The Welding Engineer

PIONEER BUSINESS AND TECHNICAL JOURNAL OF THE WELDING INDUSTRY

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DECEMBER, 1940

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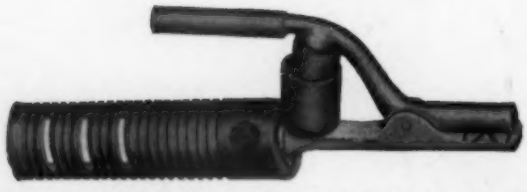

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Vol. XXV No. 12 DECEMBER, 1940

The Welding Engineer

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COVER

Mt. Rainier is never more beautiful than during the winter season (Photo Rainier National Park Co.).

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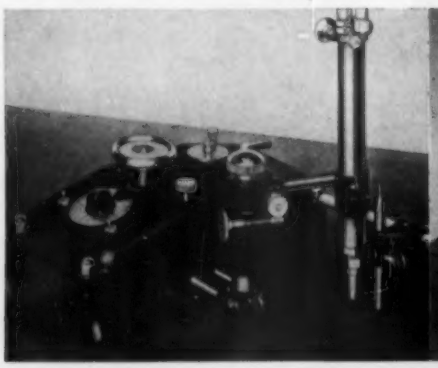
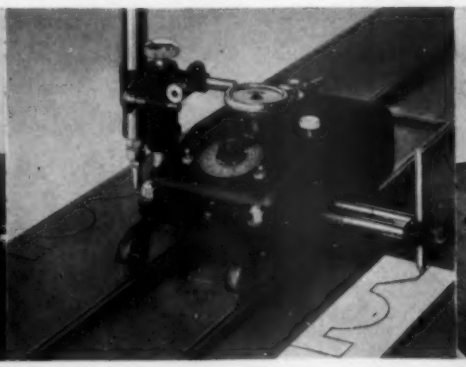
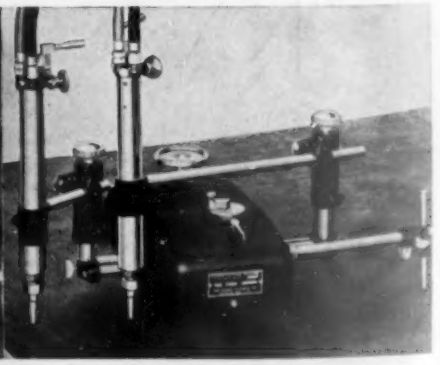
Harris Model "K" in position to cut a very small diameter circle, with a single torch mounting.



Harris Model "K" in position to cut irregular shapes. This is accomplished by combining power and manual cross feed.



Harris Model "K" in position to make a double cut, using a two torch mounting with extension holder.



What's Here?

DESIGN

The proper design and production set up will not only increase production but reduce cost in our National Defense Program. On page 21 a noted consultant on welding for production will give pointers on "tooling-up" for automatic welding of wheels for military tanks.

» «

RESEARCH

Some spot welds are too strong and consequently needlessly expensive. Others are too weak and as a result equipment fails. To arrive at a happy medium, i.e., spot welds of the proper strength, the article beginning on page 28 is suggested.

» «

PRODUCTION

Positioners are not only a tool of production but a means of obtaining welds of high quality at a lower cost. Interesting pointers on positioners are presented in an article appearing on page 32.

GENERAL

Safe working practices are an essential item in any industrial program. Especially is safety important in the welding industry (page 35), an industry so vital to our National defense.

» «

PRODUCTION

Automatic welding has long been considered a production tool. But when considering production tools one seldom thinks of automatic oxy-acetylene welding (page 34) though it ranks high as a production tool.

» «

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For those who save the back issues of The Welding Engineer, there will be found on page 39 an index of the authors and articles which have appeared in those issues of The Welding Engineer published during the year of 1940.

What's Coming?

In the January issue of *The Welding Engineer* will be found the first complete DIRECTORY OF WELDING PRODUCTS ever contemplated for the welding industry, along with the usual interesting and timely articles on all phases of welding which appear in each issue of *The Welding Engineer.*

NO. 5 OF A SERIES SHOWING
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WHETHER YOU BUILD ROADS OR OPERATE A FEED MILL

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The Welding Engineer

AMERICA'S
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Established
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Welding—
A Production Tool

WELDING HAS grown up! Prior to World War I welding was considered only as a tool of maintenance, then with the coming of the war and the increase in production demands, it was found that welding could also be used as a tool of fabrication. In the twenty odd years that have intervened the use of welding has become more extensive; in fact, in the past 8 years the use of welding has increased ten times.

Now with World War II demanding the attention of all of Europe, welding has become more than a tool of fabrication; it is definitely a tool of production. An important factor in the production of automobiles, airplanes, furniture—those countless articles that go to make life more pleasant; as well as battleships, tanks and other implements of destruction that seem to be needed to make life more secure.

Automatic operation is one of the essential features of a production line. Automatic arc welding came shortly after arc welding itself. Since then its use has been extended and has become so reformed it is difficult to associate the present day process with its early ancestors.

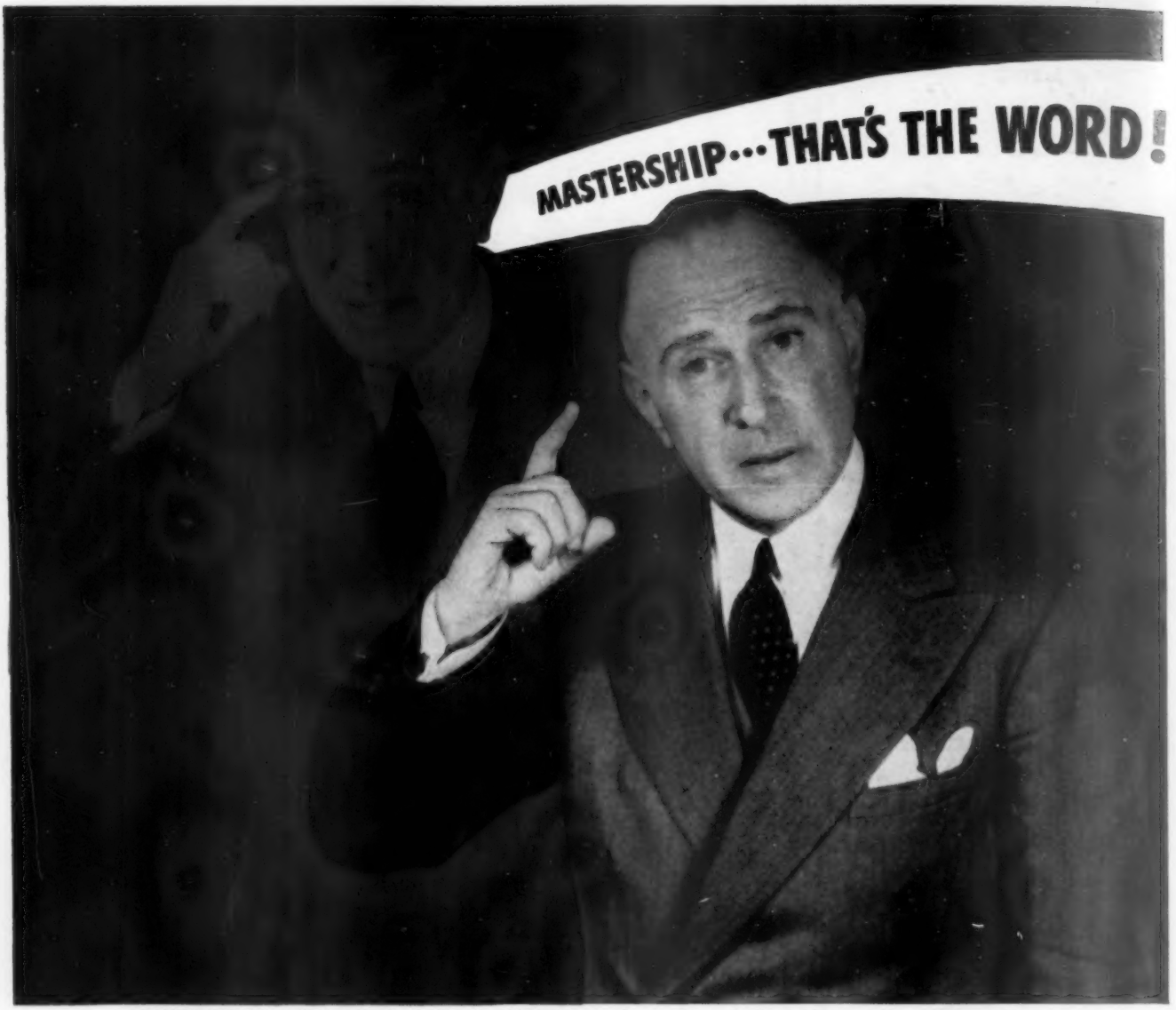
Automatic welding is usually thought of as automatic arc welding.

This is not the case, however, for resistance welders with their ingenious timing devices have taken a place in the automatic welding field.

Automatic gas welding comes to light in this issue.

Automatic gas welding, while used extensively has not received the widespread publicity of the other process so, consequently, is little known. Its automatic application, however, shows that the three major welding processes that are used for fabrication purposes are also available for production use as well. Thus, welding proves itself to be not only a production tool but a versatile tool which offers the choice of three ways to solve production problems.

J. B. Jefferson



ALTER EGO: Literally "one's other self"—the still, small voice that questions, inspires and corrects our conscious action.

ALTER EGO: We have the *ability* to get faster welding and smoother, stronger welds. Stop imagining—even to yourself—that we haven't.

Well, the shop hasn't taken any prizes so far. At least our work isn't up to expectations.

ALTER EGO: Then the boys aren't getting that something which gives them *mastership* of their ability.

You've hit the words. Now to put them to music. Let's find that something.

ALTER EGO: Maybe they need a welder that will add *flexibility* to *ability*. Why not get Lincoln's suggestion.

• •

LINCOLN SUGGESTS: A full kit of tools is essential for *mastership* of any skilled workman's ability. In arc welding, the full benefit of the welder's skill is assured by "Shield-Arc's" Dual Continuous Control which allows independent adjustment of both the *type* of arc and its *intensity* for faster welding and better welds. How? See Page 6, Bulletin 412.

LINCOLN "SHIELD-ARC" WELDING THE LINCOLN ELECTRIC COMPANY Cleveland, Ohio

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★DESIGN

U. S. Army Light Tanks (Photo James T. Barton)

Welding for Military Preparedness

By
A. M. McFARLAND

★ Automatic welding equipment for mass production of tank wheels is designed and the production problems encountered on such a job are discussed.

THE NEW armament program now being undertaken by our government has an advantage over such projects of previous years, mainly because developments in the welding industry provide new short cuts and economies. Our Army and Navy engineers realizing that speed production is essential, are taking full advantage of the possibilities afforded by welded construction. An example of this is brought out in an inquiry requesting bids on 627 tanks which were released recently by a government arsenal. As a part of specification, there was a drawing of the welded steel wheel to be used on these tanks. A sketch of general design of this wheel with dimensions is shown in Figure 1.

While the fabrication of such a wheel does not present any particular problem, making 2508 of them, four wheels for each tank, can be expedited by proper production layout. Naturally, the fabricator that is seeking this contract will desire to do it in the most economical manner because more frequently than not the low bidder is awarded a government contract without consideration as to quality, delivery, or ability; then too, the lower production cost the more likely the profit. For this reason it might be well to speculate as to the best means of fabricating this order of more than 2500 tank wheels.

In the first place, about 600,000 pounds of steel will be required just to make the wheels; a considerable portion of this being scrapped during the fabrication. For this reason flame-cutting will play an important part in the forming of these wheels. The forming of the wheel is begun by flame-cutting a central disk 24 in. in diameter, with a central hub hole, from 7/16 in. mild steel plate. The disk is then relieved of a portion of its weight by cutting out the six spokes after which it is machined to a true circle and welded to a rim. The rim is made from 4 in. by 7/16 in. steel plate; butt-welded after rolling to 24 in. internal diameter. Ribs for stiffening the spokes are obtained from steel plate and welded to the spoke and rim. While some of these pieces may be obtained more rapidly by stack cutting as to whether all are flame-cut in preference to punching will depend upon shop facilities.

The wheel may then be fabricated by automatic welding as follows: In Figure 2a, the wheel H, is held in position by the holding and rotating fixture, J, the angle of which may be adjusted by means of the turn-table clamp, U. The welding arc operates by E, near the

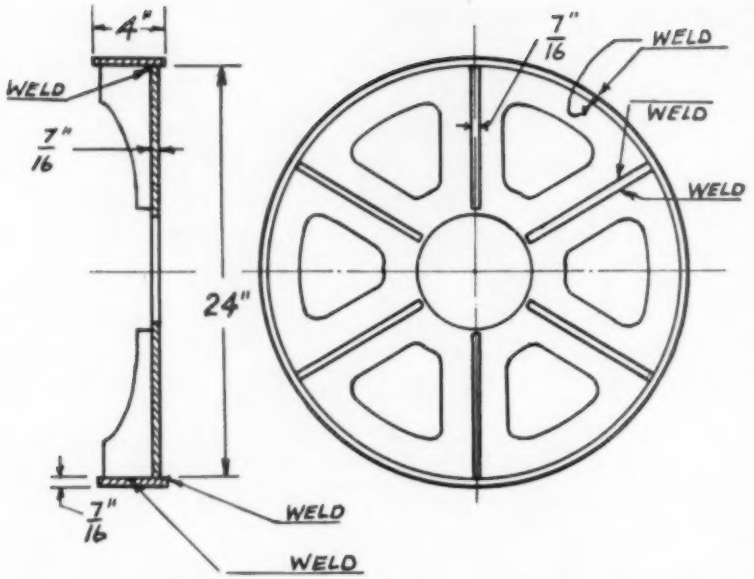


Figure 1—The problem is to make 2508 of these all-welded steel wheels.

lowest part of the wheel so that a fillet weld may be deposited in the corner formed by the rim and in the center web. The wheel and fixture are rotated by means of the worm gear G, reduction gear P and motor K. This motor drives the reduction gear through pulley M, having an adjustable pitch feature permitting speed adjustment. Thus the wheel may be rotated at approximately one-half revolution per minute, more or less, depending on the welding current and size of fillet demanded. An automatic welding head capable of handling heavy wire, is mounted on the pedestal V with a convenient means for adjusting it for height, angle and forward or back position. The wheel is so mounted to provide a quick adjustment of the arc position.

Automatic Welding Wire

An automatic welding wire about ¼ in. diameter of the knurled type with a heavy coating of suitable flux would be best for this job. Such a wire is available in all commercial sizes, from 1/16 in. to ⅜ in. diameter or larger, and in 50 or 100 lbs. coils as specified. Usually it is a soft steel from the lower end of the ingot and drawn round and smooth to size. The wire is processed by passing it between knurling rolls, which impress upon it a particular form of knurl or indents. Some wire bears a type of screw thread: other wire has depresed pits arranged in patterns to suit. The main purpose of the indents is to hold the flux below the general surface so that the wire will make electrical contact when run between the feed rollers of the welding machine, or in contact with the nozzle of the machine.

Indented Wire

Indented wire has been used during the last ten years or so, and hundreds of thousands of automotive wheels have been satisfactorily welded with it; so, although it is possible to secure a weld deposit that is more ductible than the knurled wire weld, the knurled practice has the approval of many years of service and is perfectly satisfactory for such a job as the wheel welding under discussion.

In automatic welding practice the first "set-up" is made and by trial and error the ground contact located at the spot where there is the least blowing about of the arc, the position of the arc is then adjusted with regards to the angle of inclination of the work and the correct amperage and speed of travel is determined. When these conditions are satisfied, the arc is likely to be steady and uniform and to remain so throughout the job. Therefore, the need for flux protection is not so great as in ordinary jobbing practice where the kind of work is continually changing. Frequently, an automatic job will start out with fluxed wire, and after a time shift to bare wire, without any falling off in weld quality.

To avoid lifting the coils every time a change is required, the reel holding the coil is located on the floor, and the wire is led over the guide pulley to the arc as shown.

A good substantial fillet may be obtained with a welding speed of about 3 feet per minute when using ¼ in. wire and 500 amperes of current. If more fillet is demanded, it may be obtained up to a certain limit, by slowing down the welding speed. When the fused metal accumulates too fast to be controlled, more fillet may be built up by going twice around the wheel.

A ⅜ in. wire may be used providing greater current is used. The writer has designed and set up the equipment used in welding heavy truck wheels where a rim is welded to a central portion in much this same way. On these truck wheels, speeds of 3 and 4 feet per minute were obtained, using approximately 500 amps, with either ¼ in. or ⅜ in. wire.

A varying kind of fillet may be obtained by shifting the position of the arc between the exact low part of the wheel, and some distance up the side, Figure 2b. As the arc is moved up the hill, the fused metal flows back into the arc and is puddled and smooth. The best effect is determined by trying different adjustments until the correct setting is determined.

Ground Connection

When a device of this kind is first started up, certain characteristics of the "ground connection" become apparent. A magnetic field is set up by the current flowing through the ground connection, and this may blow the arc in the desired direction, or otherwise. There is usually some place where the ground wire may be connected to best advantage. Sometimes it may be permanently connected to the central framework of the rotating fixtures, but more likely it will be found desirable to make a sliding brush contact, which always maintains the same position in relation to the arc as shown at B (Figure 2).

The butt welding of the rim calls for a suitable routine, to avoid a lot of hand work in patching up the edges of this short weld. Undoubtedly the Government inspectors will demand that the weld be sound and full, to finish smooth on the edges of the rim. It has

been found that one good way to insure this is to clamp a thin piece of steel on each end of the "Vee" (see F_1 and F_2 Figure 3) to make a dam. These steel pieces are welded into the seam and later cutting off by machining, burning or grinding. In order to penetrate through the rim the square cut ends of the rim are 1/8 in. apart and an 1/8 in. piece of copper (I, Figure 3) is set in the crack to weld against. The copper is set into the bottoming bar Q to hold it in place, and to keep it cool. When one side of the rim is welded, the wheel is turned over, the copper is knocked out and the other side welded. Sometimes it is found convenient to "line up" several such seams with a spacer between so as to make a continuous weld. This calls for some arrangements for breaking them apart upon completing the weld. It may be done by burning or machining. For continuous welding an old lathe as shown in Figure 3 and 4 may be used.

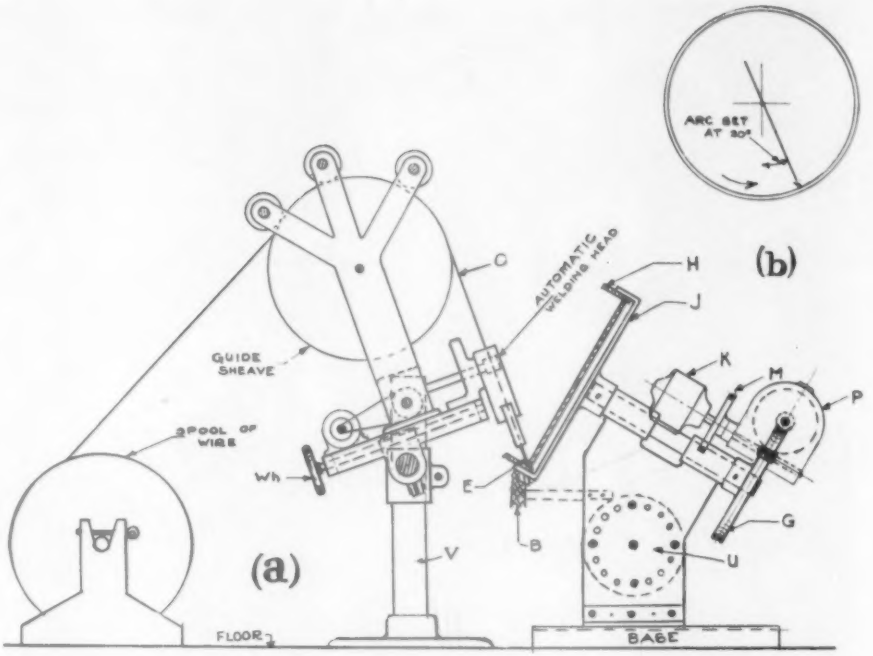


Figure 2—(a) In this sketch is shown the setup of equipment for automatically welding tank wheels; (b) shows a suggested setting for the electrode.

Butt Seams

When an automatic welding machine is used for filling in the ends of seams, such as occur in butt-welding these wheel rims, it is necessary to have the machine equipped with complete control of all operations. A control panel, within convenient reach of the operator should carry plainly marked buttons controlling wire feed, carriage feed and current. A tag marked "wire control" designates three buttons: "Up," "Down," "Stop." Normally the wire feed is under control of the automatic, and responds to the arc voltage. By means of these buttons, the operator may take manual control of the wire movements. These buttons control only so long as they are held in: When released the control goes back to the automatic. Another tag marked "Current Control" carries stop and start buttons and also one or two buttons marked "One-Half Off" "Two-Thirds Off." Assuming the normal welding current to be 500 amps., when the "One-Half Off" button is held in, resistance is cut into the circuit reducing the current flow to 250 amps. Assuming that the operator is trying to fill in the end of a seam against a "dam" or stop (F_1 and F_2, Figure 3) he might normally shut off his current when the arc reached the end. He would then have a sloping weld deposit, with a deep crater in it. Sometimes an automatic will stop the wire feed before the current is cut off. This will leave a puddle of metal with blow holes beneath the surface. However, by manipulating the control buttons listed above, the operator will be able to fill in

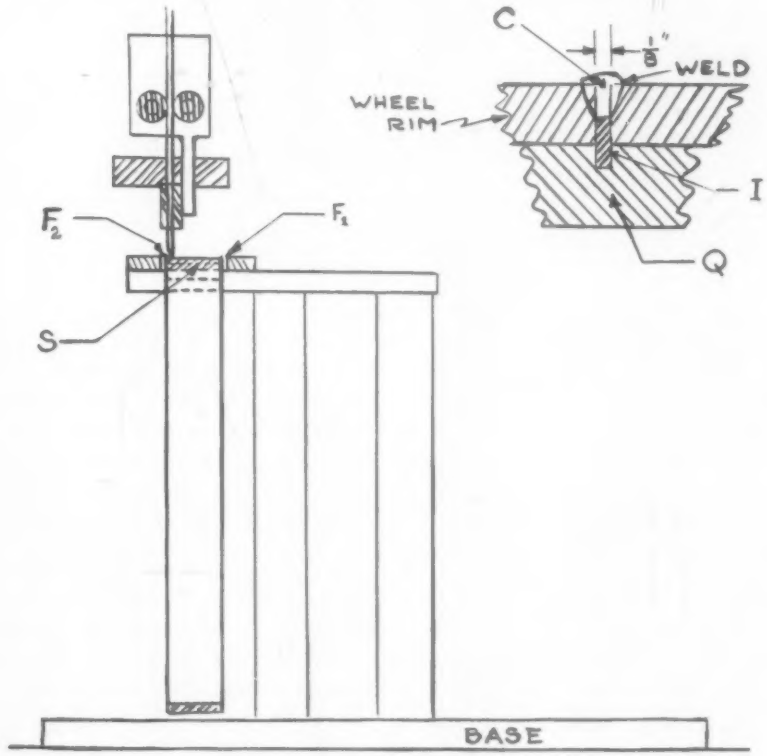


Figure 3—The thin steel pieces at each end of the rim butt seam make the weld more sound. Note the copper bar I in the cross-section.

(Continued on page 43)

Figure 1—This is the set-up for depositing bronze bearing surfaces. On the floor are several completed cylinders.

MECHANIZED oxy-acetylene welding can be divided into two broad methods. One might be called the "continuous" method, since by this method the part is completely welded in one continuous operation, such as is practiced in tube welding. The other might be called the "discontinuous" method, where the part is welded with a series of welds, or with two or more welds simultaneously made. This latter method is utilized in making washing-machine tub joints and container seams.

*Paper presented before the Annual Meeting of the American Welding Society, Cleveland, Ohio, October 20 to 25, 1940.

In the continuous type of operation the material is carried through the welding machine and past a stationary welding blowpipe by a system of rolls. In the discontinuous method, either the preformed stock is placed in a jig and rotated past a stationary welding head or the jig and material may remain stationary while the welding head travels along the seam on a track. In the continuous method the material is guided by rolls and the spacing of the edges to be welded can be changed by varying the pressure that the rolls exert. By this means, a gap can be maintained between the edges during preheat, and closed by proper location and pressure of the rolls during the welding. In contrast to this procedure the discontinuous method, which is applied to irregularly shaped pieces, requires that the edges be placed in abutment within the welding jig. In this method all of the heating is done from the top surface of the material and the bottom surface must be heated by conduction; in the continuous method separation of the edges allows direct heating of the entire surface of the edges themselves. This difference in the

★PRODUCTION

Mechanized Oxy-Acetylene Welding

By

H. T. HERBST, Development Engineer

Linde Air Products Co., Newark, N. J.

★ The advantages of automatic oxy-acetylene welding are shown. Adequate gas control and the importance of properly designed jigs and fixtures is stressed.

method of heating the edges for welding, together with the greater heat absorption from stationary clamping jigs used in the discontinuous method, results in a 40 per cent lower gas consumption when the continuous method is used.

Continuous Welding

In general the continuous method is limited to straight welds on material of uniform section. The greatest fields of applications for this method, therefore, are longitudinal seam welding of barrels, and tube welding.

In barrel welding, variations in stock thickness make necessary automatic control of heat input to the steel. This is accomplished by means of a photoelectric-cell unit which picks up light radiation from the bottom of the weld. This variation also limits the maximum practical welding rates to less than 6 ft. per min. In tube welding of coiled strip stock, these variations do not occur and welding rates in general are limited only by the capacity of the acetylene generator.

The usual practice is to have dual generators installed for continuous service. With a generator installation capable of delivering 600 cu. ft. per hr., tube welding rates of from 75 ft. per min. on 16-gauge to over 150 ft. per min. on 20-gauge are obtainable. At these rates the coiled stock is fed into a roll-type forming machine with roll forms of a design to give the shape desired. Numerous shapes, such as rectangular, oval, or teardrop, can be welded by this method.

From the forming unit, the material passes to the welding unit which usually is close-coupled to the forming mill. The welding stand generally consists of at least two sets of horizontally and vertically adjustable, water-cooled, side guide rolls. Preheating and welding takes place between these two roll sets. With proper side-pressure control of these rolls, the weld reinforcement can be built up or reduced as desired on either the outside, or the inside depending upon the use for which the tube is intended. Where perfectly flush inside and outside surfaces are desired, scarfing tools are employed to trim the weld.

After passing through the welding and scarfing stands, the tube is cooled in a water spray or bath and sized and straightened in rolls pro-

Figure 2—Two caps are being welded simultaneously to the ends of 2½ in. dia. tubing in the manufacture of automatic refrigerator parts. Note the automatic rod feed mechanism. These welds, when completed, are subjected to 1,000 p.s.i. pressure.

vided for this purpose. Then it is cut off to length in an automatic unit that travels with the tube as the cut is being made and returns to its starting position for the next cut.

Discontinuous Welding

In the discontinuous method of welding with no welding rod, the square-sheared edges of the material are placed in abutment. Since no rod is added it is important that the edges be sheared correctly and placed so that the two edges to be joined are in contact. Failure of the edges to make contact will result in a weld section thinner than the base metal. In some cases, this condition results in burning or falling through of the metal. To avoid deformation due to contraction stress, jigs and clamps used to hold the parts in position should be sufficiently heavy to absorb heat from the work-piece quite rapidly. At high production rates or on small items, it is advisable to provide water-cooling in the jigs for this purpose.

Figure 3—A general view of a machine used in automatically bronze-welding hubs to stamped fan blades at the rate of 3000 to 4000 completed fans per day.

The two most common types of welds made by this method are the vertical and girth seam welds on round or rectangular vessels. When the vertical seams are made, the rolled or formed sheet is placed in a clamp with the edges butted together. The weld can be made from either the inside or the outside, depending upon requirements of finish of the completed article. In making this weld, it is preferable to move the welding head with respect to the work. The ends of the container are welded in place next. On round shapes, this girth weld is performed best by revolving the jigs and material beneath the welding head thereby making a flat weld. On rectangular or irregular shapes, the welding head moves around the shape at a uniform rate. This type of operation provides a flush weld with a minimum of reinforcement.

A typical example of this type of weld is found in the manufacture of washing-machine tubs. The tubs consist of two parts, the side wall and the bottom. The side is formed by accurately shearing, rolling and welding a flat metal sheet into a cylinder. In one operation the bottom is stamped from sheet stock and such openings as are required are punched. As the deformation is very slight, wrinkling or stretching of the sheet is avoided. This is of extreme importance in the latter enameling operation and has an advantage over deep-drawing methods necessary for one-piece construction. It is the tendency of the deep-drawing operation to produce wrinkled surfaces or thin sections which cause rejections after enameling.

The seamed side and stamped and trimmed bottom are joined by a circumferential weld. The welds are then given a vibrating hammer operation to relieve any strain present and to remove oxide scale. A light grind follows. The tubs are then ready for corrugation and edge-rolling.

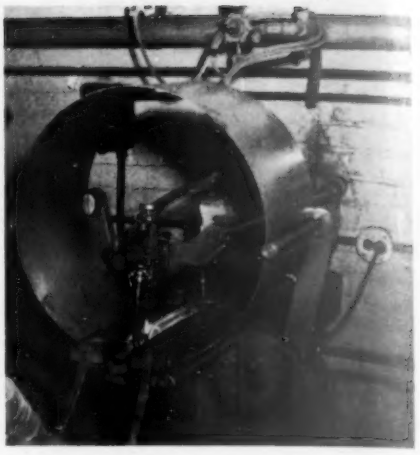


Figure 4—The side seam of this washing machine tub is being automatically welded. The joint, after cleaning, is an ideal surface for enameling.

A slight variation of this method is applicable to shapes with curved sides that cannot be made by rolling or bending flat sheets. These parts may be stamped or drawn in two halves. These then are placed together in a jig and positioned so that seams are in the same horizontal plane. The joints are then welded simultaneously with two welding heads moved by a common carriage. It should be borne in mind that this method of necessity will proceed at a slower rate than the previously described method, as the horizontal-vertical position of the weld requires a smaller weld puddle.

Strip Welding

There are numerous applications of strip welding to which automatic

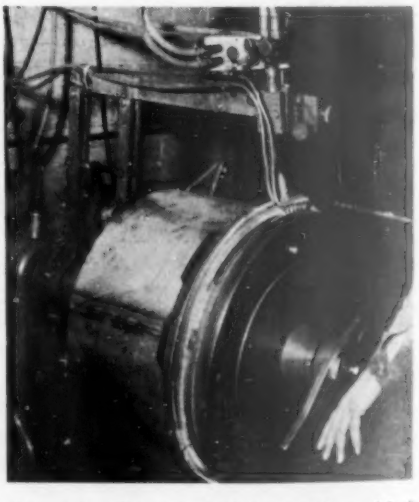


Figure 5—The stamped bottom is welded to the previously welded side of this machine tub.

oxy-acetylene welding is well suited. The softness of the weld lends itself to double- or triple-lengthening of hot-rolled coils before the initial pass in the cold-reduction mill. In this case, a weld zone that is not appreciably harder than the base metal is required to avoid marring the surface of the cold-working rolls. In addition to this, the weld strength and reliability must be such as to preclude breakage while going through the cold mill. By means of special rolls and clamping arrangements, welds are made on 10-gauge material with full penetration and strength without the use of welding rod. Two further advantages of this weld are the elimination of necessity for flash-stripping or grinding after the weld is made, and the speed of operation suitable for a recoiling or processing line.

Another application is for the welding of coils together in steel mills to meet customer demands for coils of greater length. Here the further advantages of low-cost installation and great flexibility in handling wide ranges of gauges and widths are obtained.

Heavy Welding

To obtain full-strength welds on material of 12-gauge and heavier, other than flat sheets, welding rod is used. The rod feed is made automatic through a variable-speed feed mechanism. A single welding head that has several flames so designed as to fulfill the various operation of rod preheat, plate preheat and welding generally is used. This method is suited particularly to the fabrication of cylinders and tanks requiring joints that are leakproof to dry gases.

One example of this method is in the fabrication of the pressure chamber of a household gas refrigerator. This pressure chamber consists of a length of 2½ in. tubing with caps welded on either end. These two welds are made simultaneously on an automatic machine equipped with two welding blowpipes and a motor-driven rod feed using coiled welding rod. Here the requisite leakproof joints are obtained at high production rates and with a minimum number of rejects.

This process is also applied on similar but larger machines for the production of cylinders used in shipping gases for industrial and home-cooking purposes. Here two half-shells are drawn and joined with an automatic oxy-acetylene girth weld. This construction results in lower costs than the method previously used wherein the tank was made from one full-length drawing with a dished head locked and dip-brazed in place.

Automatic Bronze-Welding

The process described above for fusion welding also can be applied to bronze-welding. The necessary fluxing action required is provided most conveniently by the use of a volatile liquid flux.

A variation of this process also is suitable for the assembly of steel parts on a production basis, such as the assembly of a fan for a portable electric-drill motor. Here a sheet stamping is bronze-welded to a machined hub. Except for loading, operation of the machine is fully automatic. The hub and fan, staked together, are loaded at one end in any of the first four of ten positions. Then ten equally spaced positioner fingers intermittently move all units on the track to the next position. The next four positions are for preheat burners located beneath the fans so that each unit, as it is moved along, is preheated at four positions. When each fan unit reaches the ninth position, a rotating stem automatically rises, and engages the fan hub. At the same time, the blowpipe tips lower into position for the welding operation, and the welding rod is fed automatically at a predetermined rate from a reel. The stem under the ninth or welding position both raises the unit into position and revolves it during the bronze-welding operation. At the tenth position, the tenth finger moves the completed fan into a tote box. The various parts of the machine are adjustable to accommodate a variety of sizes. The average actual welding time is 3 sec. and the average production rate is 10 to 12 units per min.

Stone Crusher Spider Repaired by Bronze Welding.

A different type of operation is represented in the mechanized application of bronze for bearing surfaces. A typical example is the bronze-surfacing of the cylinder lining for a rotary pump operating at 2,000 lb. per sq. inch. Here a layer of bronze is deposited on the steel surface which will later be machined, leaving a non-porous surface. Bronze-rod feed and blowpipe movement are provided by a motor-driven carriage. While the part being treated is slowly revolved, the blowpipe is moved across the surface. Volatile liquid flux, introduced to the flame with the acetylene, leaves no deposit of slag to be removed. The rate of deposition of the metal is 55 in. per min. This installation replaces hand operation at a saving of about 50 per cent in both bronze and gas.

Today the rapid method of mechanized oxy-acetylene welding is being adopted to reduce costs, improve product quality, and increase production. Installation costs are extremely low in comparison with competitive automatic welding equipment. Lower cleaning and maintenance costs and decreased reject losses usually make over-all operating costs comparable to other automatic welding methods which are notably less adaptable to changing production methods. It is universally recognized that oxy-acetylene mechanized welding has a high degree of flexibility. Where a smooth, clean surface is required, gas welding often can be used when other mechanized methods would necessitate subsequent cleaning or grinding of the piece. With the properly designed heads available today, production rates with mechanized oxy-acetylene welding are greater in many cases than those obtained with other automatic equipment. This is due in part to the greater welding speeds and shorter setup time of the mechanized oxy-acetylene equipment.

★ RESEARCH

Determination of the Strength of Spot Welds*

By
DR. J. A. NEUMAN
and
R. D. McCREERY

BEFORE GOING into a detailed discussion of strength determination for spot welded joints, we might well consider several applications of spot welding that require maximum strength. It also should be pointed out that this discussion will develop a means by which one can pre-determine the number of spot welds, of given characteristics required to carry a given load. Millions rely upon their automobile for safe transportation; yet, that would be a misplaced trust if the various spot weld joints were to break. Perhaps the greatest number of applications for the result of this discussion are to be found in the metal furniture industry because that industry shows little logical reasoning in its analysis of numbers of spot welds and supported loads. Metal chairs often contain four or five spot welds at a single joint when possibly two or three would be entirely satisfactory. Tables, desks, etc. are often fabricated at many times the maximum load to which they will be subjected. Milk-can handles, army stretchers, kitchen utensils, and many other items are fabricated with as many spot welds as the operator may think desirable, and not the number that are needed.

If a manufacturer can omit one spot weld out of every four because of correct design, welding costs will be cut considerably. On the other hand, if three spots are used where four are required, an inferior product results and possibly weld failures may cause extensive troubles.

*A paper submitted in the 1940 Resistance Welders Manufacturers Assn. Contest.

Method of Failure

Spot welded and riveted joints have several things in common. Each may fail in shear, tension or compression. Each joint has a definite efficiency as compared with the parent metal; moreover, the two methods of fabrication are interchangeable within certain limitations. A spot welded joint is stronger than a riveted joint provided the number of spot welds and rivets is equal. It has been established that a spot welded joint can carry 60% more load than a riveted joint (see pp. 390-391 ELECTRIC WELDING by Ethan Viall). In the above mentioned work, no mention is made of spot and rivet diameters, or types of material used. Conversely spot-welded joints have advantages over riveted joints. Rivets will work loose and allow movement of the component parts of the joint. In large joints, multiple spot welding is much faster than multiple riveting. Spot welding is cheaper because nothing is added to a weld except electric current, while riveting requires a punched hole and a rivet.

The Spot Diameter

The diameter of a single spot weld is a function of time and heat input to the welded joint. Maximum diameters are limited by the point diameter of the electrode. Any weld smaller than the electrode diameter may be obtained as long as there is complete fusion of welded parts.

It is obvious that a given amount of heat input is required to heat an indicated area of metal to the necessary welding temperature; therefore, if a larger diameter weld is desired, there must be more heat input to the welded area by increasing the time of heat application, the amount of heat application, or a combination of the two methods. During the compiling of the accompanying data, all welds were made on the same machine with the time, pressure, and transformer settings constant; hence, all of the aforementioned variables which would have effected the results were eliminated. Since the diameter of a spot weld is also effected by the shape of the electrodes, a copper alloy was used in the welding tips throughout the tests. Figure No. 1 on the following page shows the shape of the electrodes used. Figure No. 2 shows the type of button to

expect after a weld is opened which has been given the correct amount of heat, pressure, and time. As indicated, the metal around the spot weld tears free, leaving the weld intact on one or the other of the sheets. By obtaining the correct adjustment on the welding machine, the spot weld diameter may be made to equal the electrode diameter; moreover, the welding operation may be repeated through the life of the electrodes as long as nothing is altered.

As previously mentioned, the larger the diameter of a spot weld, the more time and heat that are required. The following table gives possible settings for KW power demand and the time necessary to make a suitable weld in various thicknesses of material.

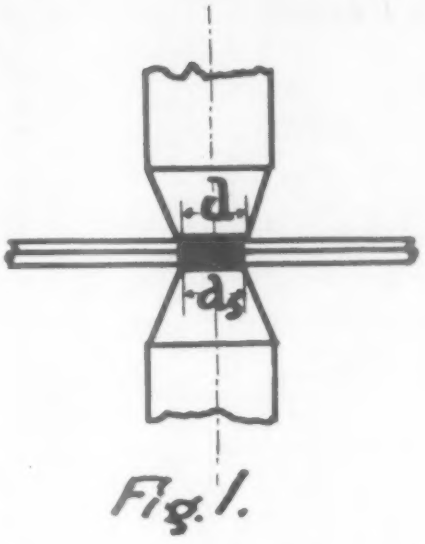


Fig. 1.

These tests were run with electrodes of this type.

Kilowatt Demand for Various Timings and Metal Thickness Using Various Diameter Electrodes.

Thickness of material inches	Time secs.	Diameter of Electrodes							
		.0983	.118	.157	.197	.236	.276	.315	.394
.0118	0.2	3.5	3.7	4	4.4	4.5			
.0197	.6	3.9	4.2	4.5	5.0	5.7			
.0315	.8	4.3	4.6	4.9	5.6	6.3			
.0394	1.0		4.8	5.3	5.8	6.6	7.2		
.0590	1.5			6.0	6.8	7.8	8.6	9.6	11.0
.0787	1.8				7.5	8.6	9.9	11.2	12.7 KW

The Welding Pressure

The pressure at the electrodes during the welding operation has a direct bearing on the current and time needed to obtain suitable results. During these tests, time and current values were carefully chosen to secure the best possible results. Since the surfaces and thicknesses of the welded samples were constant, a number of welds could be made to determine correct pressures for various metal thicknesses. In each of the following tests, pressure readings were made by means of a spring-dynamometer at the completion of each weld. A constant electrode diameter of .197 was used throughout.

Thickness of material	Pressure
.0118	22 lbs.
.0197	35
.0315	53
.0394	66
.0590	84
.0787	101

Welding Machine Used For the Experiments

For making the test welds mentioned herein, an ordinary 12 KW spot welder was used. The machine had six steps of heat regulation with a secondary open circuit voltage from 2.1 volts to 2.75 volts. Timing was accomplished by means of a mechanically operated switch. Pressure adjustments were accomplished by means of an adjusting screw on the end of the pressure spring.

Mild Steel Sheets Used in Experiments

Ordinary drawn and stamped mild steel sheets were used for the tearing experiments. Similar metal sheets are used in the following industries:

US Ga #30—Light pot and pan industry.

US Ga #25 to #20—Stove, refrigerator and enamel industries.

US Ga #20 to #16—Metal chair, automobile, and heavy container industries.

The surface condition of the metals, as mentioned in previous considerations, plays a decisive part in obtaining good welds. Dirty and scaly metals cannot be as easily welded as clean metals in spite of the most modern of equipment.

The color of the sheet metals also influences the results. Metals with thin oxide coatings may be any of several colors and will offer considerable resistance to the flow of current.

Failures of Spot Welds

The tensile strength of the sheet metals used in the experiments were as follows: (Average of three experiments)

at	.0118	it	was	49,000	lbs./sq. in.	
"	.0197	"	"	52,900	"	"
"	.0276	"	"	53,700	"	"
"	.0394	"	"	55,800	"	"
"	.059	"	"	53,500	"	"
"	.0787	"	"	50,700	"	"

The .059 and .0787 sheet metals were colored a light bluish grey. The .0276 metal was silver grey and showed very fine lines or corrugations; moreover, one could conclude from experience that the latter sheet is ideally suited for welding.

The sheet metals used in the above tests were cut in strips, varying in width between $1\frac{3}{16}$ and $1\frac{1}{4}$ in. The strips were overlapped and joined by one or more spot welds, as shown in Figure No. 3.

After obtaining the most advantageous adjustment for making the attached tests, five samples were made for each thickness of metal and each group of five were welded under identical conditions. The results obtained were averaged, and listed first in the groups of two of the data sheets. The one sample giving the best results of each group of five was marked "a" and appears second in each group of two.

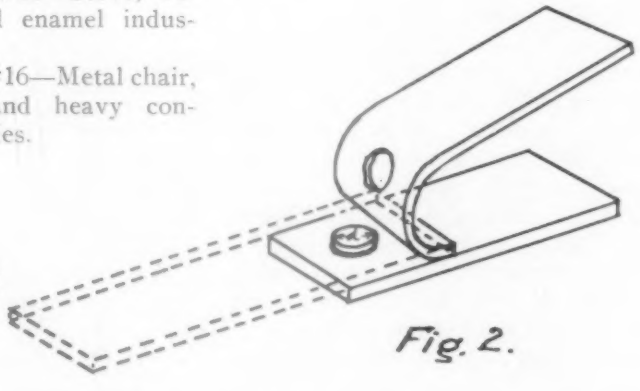


Fig. 2.

This is the button to be expected after the weld is opened.

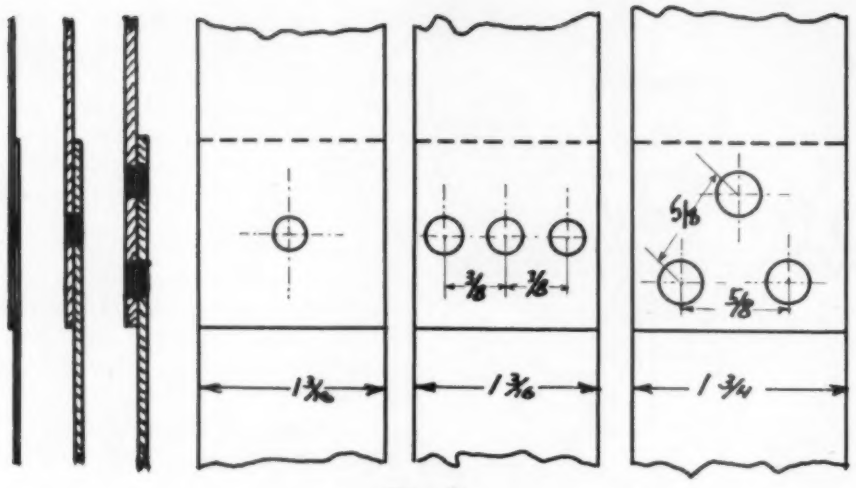


Fig. 3.

The test specimens were overlapped and joined by one or more spot welds.

Single Shear — Two sheets held together by spot welds are placed in direct tension when resisting a load. The two pieces tend to slide past one another and shear the weld. In the aforementioned case, the area of metal resisting the force is $\frac{\pi d^2}{4}$ (see Figure No. 4).

Combined Stresses, Sd—In most cases, the two pieces of metal are not in a single plane; hence, a moment force actually exists when the metal is placed in tension. The force of the moment is such that the two pieces of metal tend to assume the position shown in Figure No. 5. However, tearing experiments have demonstrated the value obtained is in close comparison with the yield point of steel. The angle of deformation always started at approximately one-third of the total breaking load. After deformation is complete, the spot welds tend to show the first signs of failing around the circumference. This is caused by the plastic flow of metals in tension. Mild steel has an elongation of about 30%; hence, the metal thins and pulls away from the weld causing the failure at the circumference. The load then appears to be distributed over the area πd which causes the metal at the edge of the weld to be in both tension and compression, and not pure compression, as is a riveted joint. With the above in mind, we see that a neutral axis exists through the center of the weld. On one side there is compression and the other tension of the metal; therefore, the resisting area is not the circumference of the weld but is the projected area 2d x t, as is shown in Figure 6.

Tensile Tests

In Table No. 1, the test of .0118 sheets shows that the Sd stress reached a maximum with the electrode diameter equal to .118; moreover, it is of interest to note that there was a marked decrease in strength as electrode diameters were increased. Table No. 2 shows a similar result to that found in Table No. 1. In Table No. 3, 5, and 6, there is no noticeable diameter that will produce the strongest weld. The maximum load and average load in Tables No. 5 and 6

Exp. No.	Electrode diam. ins.	Width of material ins.	Ultimate load lbs.	Ultimate stress lbs.	Type of break
Table 1 — Thickness of material: .0118 ins. — 1 spot weld, overlapped					
1	.0984	1.181	128	54760	torn off
1a	.0984	1.181	141	60590	torn off
2	.118	1.181	148	52630	torn off
2a	.118	1.181	162	61440	torn off
3	.157	1.181	194	52050	torn off
3a	.157	1.181	220	59170	torn off
4	.197	1.181	229	51200	torn off
4a	.197	1.181	268	57600	torn off
5	.236	1.181	255	45510	torn off
5a	.236	1.181	277	49780	torn off
Table 2 — Thickness of material: .0197 ins. — 1 spot weld, overlapped					
6	.0984	1.377	212	54620	ptly. burst off
6a	.0984	1.377	242	62580	torn off
7	.118	1.377	238	51200	torn off
7a	.118	1.377	278	60450	torn off
8	.157	1.377	324	51200	torn off
8a	.157	1.377	388	62580	torn off
9	.197	1.377	406	52340	torn off
9a	.197	1.377	481	61870	torn off
10	.236	1.377	450	48360	torn off
10a	.236	1.377	540	59030	torn off
Table 3 — Thickness of material: .0275 ins. — 1 spot weld, overlapped					
11	.118	1.377	364	56040	torn off
11a	.118	1.377	419	64000	torn off
12	.157	1.377	496	56890	torn off
12a	.157	1.377	584	67560	torn off
13	.197	1.377	551	51200	torn off
13a	.197	1,377	661	61160	torn off
14	.236	1.377	639	49070	torn off
14a	.236	1.377	783	60450	torn off
15	.275	1.377	738	49210	torn off
15a	.275	1.377	926	61440	torn off
Table 4 — Thickness of material: .0393 ins. — 1 spot weld, overlapped					
16	.118	1.377	496	53340	burst off
16a	.118	1.377	562	60450	burst off
17	.157	1.377	595	48360	ptly. burst off
17a	.157	1.377	761	61440	torn off
18	.197	1.377	794	51200	torn off
18a	.197	1.377	981	63290	torn off
19	.236	1.377	925	49780	torn off
19a	.236	1.377	1058	56890	torn off
20	.275	1.377	1102	50490	torn off
20a	.275	1.377	1246	57180	torn off

Table 5 — Thickness of material: .05905 ins. — 1 spot weld, overlapped

Exp. No.	Electrode diam. ins.	Width of material ins.	Ultimate load lbs.	Ultimate stress lbs.	Type of break
21	.157	1.575	959	51920	ptly. burst off
21a	.157	1.575	1146	61440	torn off
22	.197	1.575	1190	51200	torn off
22a	.197	1.575	1356	58320	torn off
23	.236	1.575	1345	48360	torn off
23a	.236	1.575	1543	55470	torn off
24	.275	1.575	1499	44860	torn off
24a	.275	1.575	1852	58690	torn off
25	.315	1.575	1653	44520	torn off
25a	.315	1.575	2271	54900	torn off

Table 6 — Thickness of material: .0787 ins. — 1 spot weld, overlapped

26	.197	1.772	1543	49720	burst off
26a	.197	1.772	1797	57890	burst off
27	.235	1.772	1742	46940	ptly. torn off
27a	.235	1.772	2117	56900	torn off
28	.275	1.772	2094	58070	torn off
28a	.275	1.772	2425	56020	torn off
29	.315	1.772	2315	46370	torn off
29a	.315	1.772	2910	58600	torn off
30	.394	1.772	2666	44090	torn off
30a	.394	1.772	3660	59090	torn off

Table 7 — Thickness of material: 0.197 ins. — 3 spot welds in line, distance apart 3/8 ins.

31	.0984	1.772	525	45230	torn off
32	.118	1.772	679	47710	torn off
33	.157	1.772	893	48070	torn off
34	.197	1.772	1124	48360	torn off
35	.236	1.772	1221	49210	torn off

Table 8 — Thickness of material: .0394 ins. — 3 spot welds in line, distance apart 5/8 ins.

36	.118	1.772	1345	48360	torn off
37	.157	1.772	1720	46290	torn off
38	.197	1.772	2337	50550	torn off
39	.236	1.772	2623	44090	torn off
40	.276	1.772	3086	47500	torn off

Table 9 — Thickness of material: .0591 ins. — 3 spot welds in triangle, distance apart 5/8 ins.

41	.157	1.772	2513	44950	torn off
42	.197	1.772	3064	43520	torn off
43	.236	1.772	3792	45660	torn off
44	.276	1.772	4475	45090	torn off
45	.315	1.772	5093	45510	torn off

Table 10 — Thickness of material: .0197 ins. — 3 spot welds in triangle, distance apart 5/8 ins.

46	.0984	1.772	584	50070	torn off
47	.118	1.772	745	50550	torn off
48	.157	1.772	948	52340	torn off
49	.197	1.772	1195	49780	torn off
50	.236	1.772	1345	50350	torn off

Table 11 — Thickness of material: .0394 ins. — 3 spot welds in triangle, distance apart 13/16 ins.

51	.118	1.772	1400	50070	torn off
52	.157	1.772	1874	50550	torn off
53	.197	1.772	2425	52340	torn off
54	.236	1.772	2778	49780	torn off
55	.276	1.772	3263	50350	torn off

Table 12 — Thickness of material: .0591 ins. — 3 spot welds in triangle, distance apart 1 ins.

56	.157	1.772	2800	51490	torn off
57	.197	1.772	3263	46940	torn off
58	.236	1.772	3968	47500	torn off
59	.276	1.772	4850	49780	torn off
60	.315	1.772	5445	48640	torn off

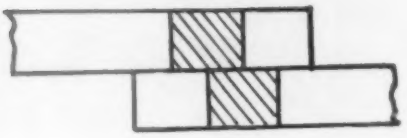


Fig. 4.

Shear in a spot weld.

differ considerably and ultimate stresses are lower than in Tables No. 2 and 3.

In summarizing, one can assume that there is an indication of an optimum diameter for a spot weld. This is substantiated by the fact that at maximum loads in .0157 material, an electrode diameter of .197 was the most efficient.

In regard to the specimens containing three spot welds, a slight decrease in the expected ultimate stress can be noted. This results from two of the three spot welds being smaller than the electrode diameter. It is an established fact that in a series of spot welds, the first weld will steal current from any following welds; hence, the latter welds are smaller.

As is indicated in the results and especially in Table No. 8, it is correct to assume that three spot welds will give approximately treble the value of a single weld.

Staggered welds show a slight strength increase over the same number placed in line. The variation is caused by a decrease in the deformation angle, which in turn is caused by the fact that in staggered welding, all welds must be destroyed simultaneously to obtain failure. Welds in line concentrate all the stress in a single line of resisting metal until that portion fails. The line of concentration then moves along successively until the entire joint has failed.

Conclusion

The welded specimens herein discussed and the data indicated in the accompanying table has given us a means to draw certain conclusions.

(Continued on page 42)

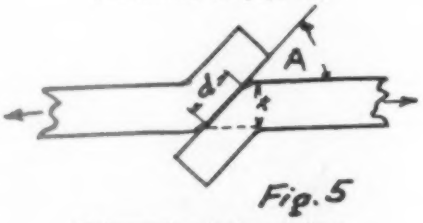


Fig. 5

Deformation before failure.

POSITIONERS PROMOTE ECONOMY

By
ROBERT LATTICE

OUR NATIONAL defense program has brought an ever increasing flood of government orders into the field of welding. As a result many shops are being introduced to the highest type of welding: something that may not have been demanded by the type of work formerly undertaken by these shops. Most startling is the emphasis placed upon proper positioning for welding. All welding minded persons are familiar with the fact that positioned welds made with heavily coated electrodes are the best; both quality and cost are well served by the weld made in the flat position. Many structures however, do not lend themselves to such positioning. At least, strict positioning is something that can be had only with difficulty; tying up jib cranes and travelling cranes to promote welding speed.

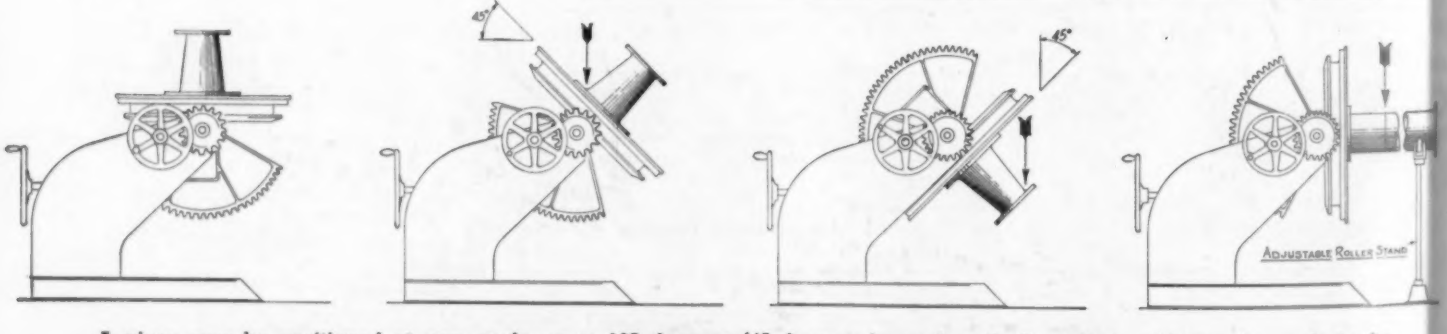
To free the cranes for handling jobs other than positioning, for which they were ill-suited at best, welding positioners have been brought out. Here is a tailor-made device that can place welds in the proper position for the best welding practice. A function they performed quickly, economically, safely and easily.

Consider the question of speed! Whereas speed was formerly a factor very essential to the reduction of overhead or burden costs, speed is now a measure of patriotism. Time has become an important consideration in our welding work much of which will be directly or indirectly coupled with war needs. Limited shop facilities, not to mention the ever-growing scarcity of skilled artisans, spotlight any equipment that enables the craftsman to produce more work in less time. Such a production boost is readily accomplished by the simple addition of welding positioners to ordinary shop handling devices.

The increased speed of welding brought about by positioning might be considered advantage enough. Yet, the further benefit of eliminating costly crane tie-ups which invariably slow production throughout the plant must not be overlooked. Cranes, both jib and travelling, are specialized machines adapted to loading and unloading or general shop moving operations and no shop superintendent wants to saddle these expensive devices with a simple positioning operation that could be done much better with other equipment. So the welding positioner is utilized in a practical manner for holding weldments to facilitate the best welding possible while the cranes give unimpeded service in the type of work for which they were designed.

Second to speed in national importance is economy. Appropriations are based upon dollars. The less expense involved in manufacturing a certain defense item, the more of these units may be procured by the government. All welding executives are familiar with the cost of positioned welds as compared to out-of-position welds. The latter cost more than twice as much as the former.

★ Positioners not only promote economy but safety as they increase production. This is especially true where welds of the highest quality are desired.



A piece may be positioned at any angle up to 135 degrees (45 degrees beyond vertical) so that weld may be made in the downhand position. Aided by a roller stand, positioners may be used for rotating pipes or long cylinderical pieces for welding. The arrow indicates the point of welding. (Drawing by Ransome Concrete Machinery Co.)

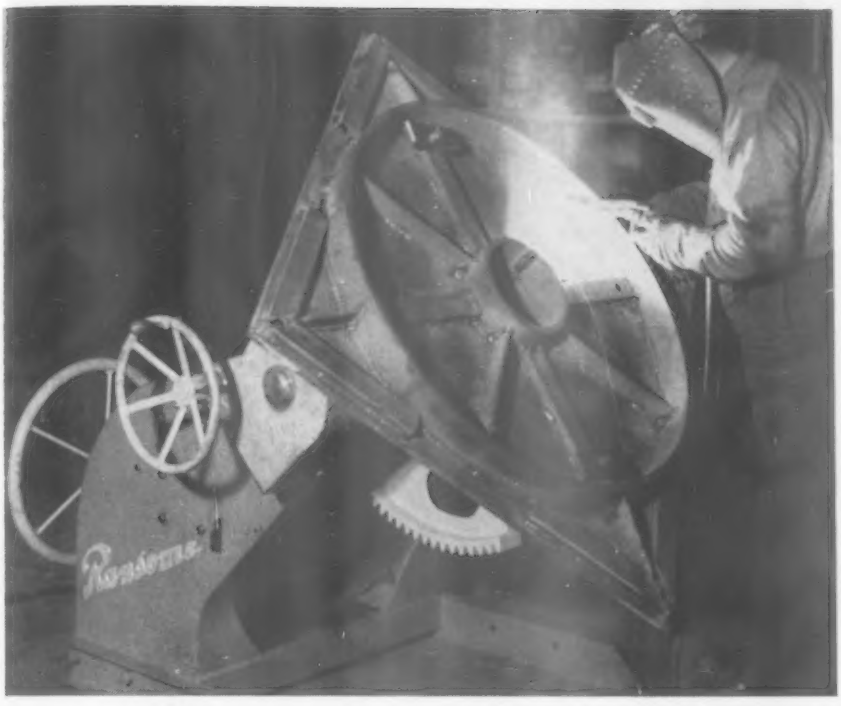


Figure 1—The 2500 lb. capacity hand operated positioner readily positions a trunnion housing for down hand welding. (Photo Ransome Concrete Machinery Co.)

Smaller diameter electrodes and less current are the explanations. Where gravity co-operates with the welding operation as it does in all downhand work, larger molten pools are readily controlled.

This fact may be seen readily by consulting Table I which represents a time study analysis of the time required to deposit 1 in. fillets on 1 in. plates:

Table I—Time required per foot of one-inch fillet weld:

Position	Arc Time	Cleaning Time	Total Time
Vertical	29	5	34
Horizontal	15	4	19
Downhand	12	2	14

Positioning is the natural answer. But to go further on the basis of cost; most welding operations will show that arc time will represent less than one-half of the entire welding time that goes into the job. Even if it represented one-half the time, the above figures show that downhand welding is the preferred from a cost standpoint.

Then along with economy for both shop owner and government (all of us) comes a higher quality of deposit. All position electrodes are capable of depositing excellent weld metal possessing freedom from x-ray defects and displaying physical properties of the highest order. These results, however, are obtained consistently only when the welders are highly skilled. On the other hand the downhand electrodes produce the same soundness of deposit with equal or better physical properties in the hands of less skillful workers. Thus the welding positioner opens the door to the new weldors demanded by industry without sacrificing the quality of deposit.

Safety is the next consideration. Slings and chains present a hazard every time they are used. Even in the hands of experienced riggers this is true. How much more correct is this statement about the dangers of slings and chains when a weldor is called upon to use them on the job at hand!

In Figure 1 a trunnion housing is being fabricated with the aid of a hand operated 2500 lb. capacity welding positioner. The work is done easily as the operator moves the structure by means of the two conveniently located handwheels.

Welding work varies as to size and weight. For this reason the welding positioners on the market today are available in a range of sizes. Standard capacities run from 1000 lbs. to 16,000 lbs. Load ratings for the 2500 lbs. size are figured with the center of gravity of the load six inches above the table. Similar ratings for the larger positioners contemplate the center of gravity position as being twelve inches above the table top.

A large structure, shown in Figure 2, may be handled with the utmost ease on the 6000 lb. positioner. This weldment which is approximately 25 ft. long has been tilted 45° from the vertical to enable the weldor to make a flat position fillet weld. It is not at all unusual for two or more weldors to work at the same time on larger assemblies such as the one illustrated.

Figure 2—This weldment is 25 ft. long and positioned at 45° so that the two welders can make a down hand fillet weld. (Photo Cullen-Friestedt Company.)

Any required angle may be set quickly by means of the convenient motor switch shown just ahead of the weldor in Figure 3. A steady and comfortable working position is assumed by the welding operator who is using both hands to guarantee a steady arc. The locomotive crane body on which the weldor is working has been tilted through an angle of 45° as well as being partly rotated. In Figure 4 is shown the same structure tilted through 135° this time to bring the bottom welds into position.

Certain abilities of the welding positioners deserve review. These versatile devices permit welding on the sides, bottom and top of a job with but *one* set-up. The working table may be tilted through 135°, 45° beyond the vertical position. Then, no matter what the angle of tilt, the whole table may be rotated through a complete circle. In this way it is possible to position all welds of a job for downhand welding without any re-handling.

Home-made positioners may be seen in many shops. As a general rule these handling units lack both the worm gears of the ready-made articles and the positive control of the geared hand wheels. In these cases the home-made devices will not lock in fixed position and, very often, are unbalanced to a large extent. Some of them require a good firm grip at all times to hold them in line in some positions while stubbornly resisting all efforts to move them in others. Particularly has this been the case where circular objects like those encountered in pressure vessel work have been handled.

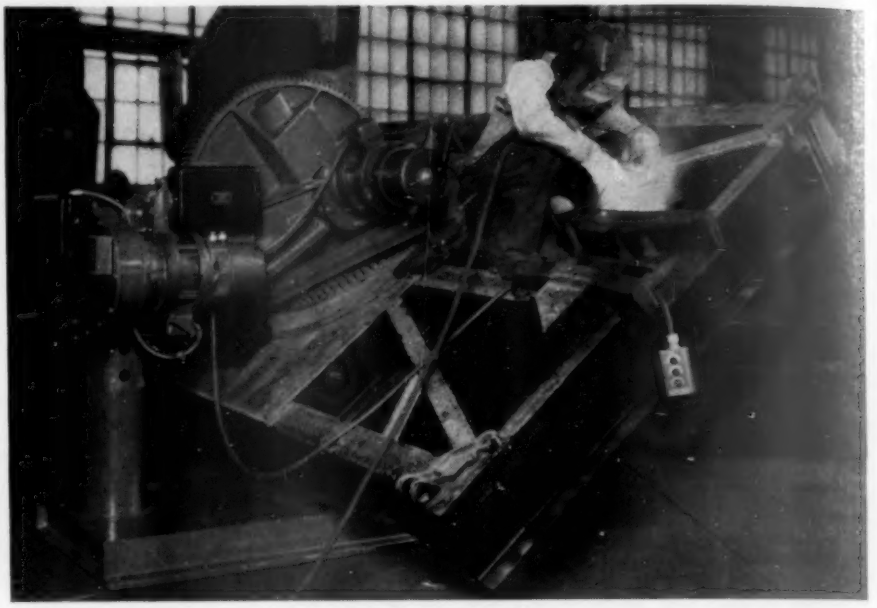


Figure 3—Here is a locomotive crane body tilted through 45° and partly rotated. (Photo Cullen-Friestedt Co.)

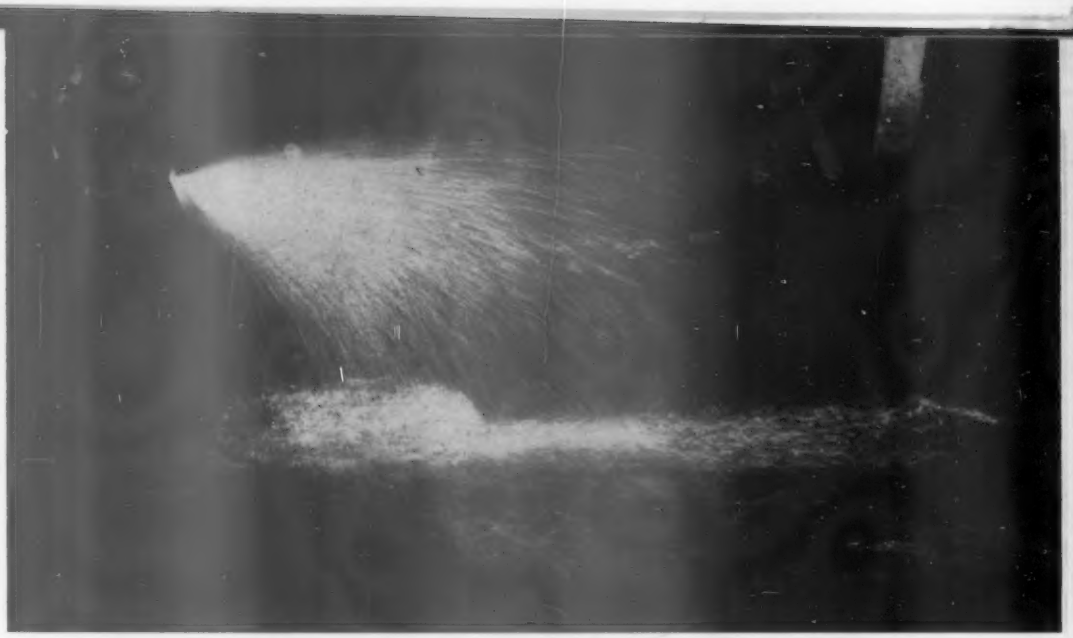
Two types of motor drive for the table rotation are provided: constant speed and variable speed. The constant speed motor may be operated intermittently to vary the speed of rotation while the variable speed drive allows the work to move past the operator without starts and stops. With the variable speed drive the weldor is enabled to hold his electrode in a fixed position while the work rotates before him. The various speeds are very quickly set by adjustment of the transmission to suit work of different diameters.

The tilting and the rotating movements of the table are controlled independently. On the hand operated tables tilting and rotating movements are each operated by separate hand wheels through self locking gearing. Similarly the power operated positioners have independent motor drives, also self locking, for tilting and rotation. The flexibility of the hand operated tables is improved by disengaging the rotating table to allow a balanced or circular job to be freely rotated by the weldor, whatever the position, without using the hand wheel.

Much more might be said about the utility of welding positioners in welded fabrication. For the applications of the device have, as yet, been limited only through the ingenuity of the user. That positioners are a worthwhile piece of plant equipment is beyond doubt when the many plural purchases of these units are considered. One machine might be purchased as a result of curiosity. Later purchases by the same organization indicate worth.

Figure 4—The same structure as pictured in Fig. 3 has been tilted through 135° to make the bottom accessible for welding. (Photo Cullen-Friestedt Co.)

★ SAFETY



Sparks from a cutting torch travel far as they roll and bounce along the floor.

Safe Welding Practices

★ Increased activities in our industrial plants will require increased vigilance. A simple safe practice program, however, will minimize the danger.

H. A. SWEET
Engineer
Associated Factory Mutual Fire Insurance Companies
Boston, Mass.

IN THE NATION'S haste to apply available manpower effectively in this period of production for defense, there may be a tendency to overlook the vital needs of fire protection, though, as a matter of fact, greater emphasis must be given now to fire safety than in less turbulent days. This is particularly true in welding and cutting operations where any deviation from the established and safe routine may spell disaster.

In Factory Mutual plants, until the last year, it was believed we had gone a long way toward reducing fires from welding and cutting. In 1923 there were 20 such fires in Factory Mutual plants; by 1929, a year of high industrial activity, and following the wider use of the torch the number had risen to 69; then, after a reduction of a few years, they rose again to 126 in 1937.

This increase led the Inspection Department to take steps, as the saying goes, and inspectors discussed with plant managements the hazards involved and the safeguards necessary. Largely because many plants recognized the hazards and applied the suggested safeguards, the reported fires were reduced to 84 in 1938; but again due to increased activity the number rose to 108 in 1939.

Cutting Precautions

No one knows what the present period of industrial activity will bring forth. It has been the national experience that when production goes up, the number of fires increase, both actually and relatively. But this need not be true in the present situation. Cutting and welding fires can be prevented, and protection can be provided for those that do occur so losses are kept to a minmum.

Any fire started by the use of cutting and welding equipment has serious possibilities of danger to life, property and business, depending upon the conditions where the fire starts. Recently, in an electric power station, sparks from a portable acetylene torch were drawn into and ignited the oil-saturated steel wool air filter on the cooling duct to six 2,000 kva. transformers. Due to the draft of the fans and the accumulation of coal dust inside the duct, fire spread quickly to three of the large airblast transformers and caused a loss of about $14,000.

In a rubber shoe plant, where workers had received careful instructions on the use of cutting and welding torches, a weldor and his supervisor failed to observe the established precautions. Sparks from their torch dropped through a hole in the floor and ignited bales of cloth shoe lining stored in the basement. The automatic sprinkler operated but considerable material was damaged and the loss was $1,000.

On another occasion welding and cutting operations on heavy channel

Sparks bounce off cap of aide holding ladder for cutting job in an air shaft in the Westinghouse plant.

irons used in constructing a large trailer chassis were undertaken in an unsprinklered, combustible addition to the main building of an automobile assembly plant. After the work was finished and the workmen gone, fire broke out, opening 294 sprinklers in the main building. This, together with hose streams, lowered the water pressure from tanks and the fire pump until the sprinkler pressure was ineffective. Consequently the blaze destroyed the addition and a large part of the main building, at a loss in excess of $40,000.

These are common fires resulting from welding and cutting, happening at the rate of about two each week in Factory Mutual plants. Under the stress of increased production of defense supplies and armament, this number may be considerably increased if due precautions are not taken.

Greatest Danger

Experience shows that the greatest danger in cutting and welding operations comes from the use of portable equipment that can be taken to any part of a plant. It is customary, of course, to provide a permanent welding and cutting shop where the bulk of the work can be done safely. But away from the normal safeguards of such a place, almost anything can—and does—happen.

When used without proper safeguards in locations where woodwork, combustible storage or flammable liquids are exposed to the sparks and hot slag, trouble is almost sure to follow. These sparks are by far the most frequent causes of cutting and welding fires. They hold the heat for some time, often igniting light, combustible material. They also start smoldering fires that may not be discovered for some time. The sparks sometimes fly through pipe openings, cracks or other openings in walls and partitions, starting fires out of sight of the men on the job. They also cause fires by lodging in oily engine pits, tarpaulins, wood chips, rubbish, etc.

Over a period of ten years, only eleven per cent of the welding and cutting fires in Factory Mutual plants were caused by the heat of the torch itself or welding arcs, backfiring of torches, or by failure or abuse of the equipment.

Planned Protection

The precautions to be taken for any situation where cutting and welding is used must be adequate for the conditions involved. It is not enough to recognize the hazard. The protection must be planned to give the desired safety. Protection begins with adequate supervision in the hands of a qualified person with authority necessary to enforce the requirements of his job. He should examine the location of all proposed work, plan the necessary protection or order that the work be done in another location, if conditions are not safe. Then he must specify the precautions to be taken and issue a permit accordingly. No welding or cutting should be permitted outside of the permanent shop without that permit.

The Chrysler Corporation, in all its great plants, has adopted these general practices. The maintenance foreman first examines the site where the work is required in company with the foreman of that department. If the maintenance foreman decides there is no fire hazard, he notifies the fire chief of the plant accordingly and issues a permit to the operator. The maintenance foreman and the department foreman sign the permit.

If a fire hazard is involved, the fire chief also inspects the location and a different permit is issued requiring the signature of all three men. When the job is finished, the operator returns the permit to the maintenance foreman who passes it on to the fire chief for his records. Contractors doing welding or cutting in the plant are subject to the same procedure.

The human element is very important in controlling this hazard. A number of fires have occurred where precautions were taken because the estimate of the hazard by the men involved has been faulty. In one case a cloth curtain was used to confine the sparks, but the curtain was ignited. In another, a canvas tarpaulin and

(Continued on page 44)

A fire extinguisher is a part of the cutting equipment at the California & Hawaiian Sugar Refining Co. plant.

Runner showing fractured and cracked blades which were repaired in 6 hours by Tobin Bronze repair-welding.

Repair-welding of fractured blade in power plant turbine completed in 6 hours

A SERIOUS SITUATION developed in Banff, Alberta, not long ago. It was discovered that a blade in one of the two turbines of the local power plant was fractured. To make matters worse, closer examination revealed that four other blades were badly cracked. The turbine was useless. To dismantle and make the repair meant a delay of at least two to three weeks. To replace the turbine meant an outlay of about $1,200 and a delay of from three to four months. For a while, it appeared as though Banff were in for a "blackout." Then, repair-welding was suggested.

Through a 14″ manhole, Mr. Jackson of Jackson Welding Shop, Calgary, welded the fractured and cracked blades in just 6 hours—actual welding required only 2½ hours; preparation, 3½. Only 4 lbs. of Tobin Bronze welding rod were needed to avert what might have been a serious situation.

This demonstration of the value of Tobin Bronze welding is typical of many which prove that Tobin Bronze is ideal for the general repair-welding of cast iron. The genuine is marked "Tobin Bronze Reg. U. S. Pat. Off." 40130

ANACONDA
from mine to consumer

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Company

New Product Developments

The Ideal Brush Concaver

Carbon Brush Concaver

★ It's easy to correctly form brushes to the commutator curvature with a new device just announced by the **Ideal Commutator Dresser Co.**, 1935 Park Avenue, Sycamore, Illinois.

The old brush is used as a template to accurately locate the arc segment on the cutting guide slot, which arc corresponds to the contour of the commutator or slip ring. After this segment is found the new brushes may be formed without further set up.

Any electric drill or electrical shaft drive may be used to operate the cutting head. The complete unit includes aluminum guide casting, cutting file, removable angle plate with clamping device and "C" clamp. Takes practically any size brush for 4" to 48" diameter commutator.

» «

Flux Coated Bronze Welding Rods

★ A new **High-Test Flux-Coated Bronze Welding Rod** has recently been announced by **Air Reduction**, New York. It is claimed to offer eight advantages for bronze welding operations:

1. Low fuming. 2. Applies faster. 3. Denser deposit. 4. Increased tensile strength. 5. Greater bond strength. 6. Increased hardness of deposit. 7. Materially improved ductility. 8. Time saving.

Each of these qualities is an asset that every experienced buyer will appreciate. Time formerly lost in removing a bare rod from the molten puddle and dipping it into a flux can is time saved when Airco High-Test Flux-Coated Bronze Welding Rods are used. The flux is said to adhere splendidly in shipment and in use. It is also stated that it will not fall off when the rod is excessively bent.

For those who prefer a bare welding rod, the same flux is available in a liquid paste form. For full information and descriptive literature write Air Reduction, 60 East 42nd Street, New York, N. Y.

Welding Positioner

★ **The Bentley Weldery, Inc.**, Syracuse, New York, now offers for general sale a new type **Welding Positioner**, of all-welded construction which it has heretofore been building on special order for shops engaged in quantity production of welded parts. These "Production Positioners" are designed; first, to facilitate rapid set-up and tacking, and second, to automatically position the work at angles of tilt and rotation best suited for each individual weld.

Rapid set-up and tacking is said to result from a design in which the face plate is at bench height when horizontal, yet all of the supporting structure, motors and controls, are located under this low face plate, giving free access to the work from all directions. A hand operated clutch is provided to permit rotating the work by hand when desired. The face plate raises as it tilts, not only maintaining a convenient working height when it is vertical, but also providing sufficient floor clearance for swinging a six foot diameter assembly in this position. Additional floor clearance may be secured by raising the entire machine on its central supporting column.

Automatic positioning is accomplished by the use of adjustable trips, engaging control switches in combination with motors equipped with magnetic brakes. To set-up, an assembly is "inched" into the best position for the first weld, and a trip is set to engage the corresponding limit switch. This procedure is repeated through all the various positions required. These are then automatically duplicated for the remainder of the production lot. In actual operation, it is claimed the operator will often, after pressing the proper control button, start the next weld before motion has ceased, thereby reducing "non-welding" time to an absolute minimum.

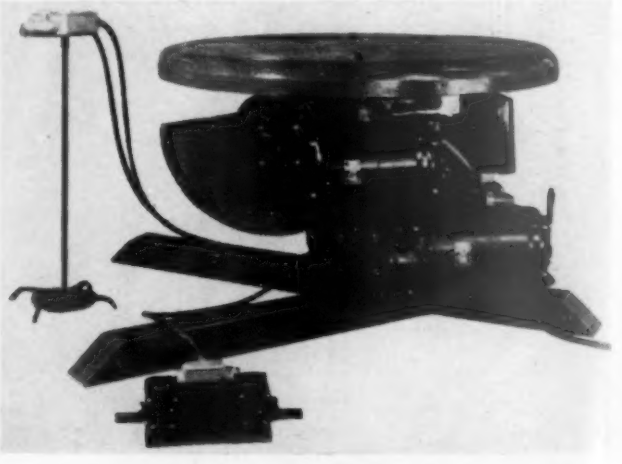
For circular welding, a foot-pedal control is provided which is independent of the automatic indexing above described. Thus while rotation may be automatically controlled for any number of straight line welds, yet when making circular welds rotation occurs without interruption while the foot pedal is depressed, and stops when it is released.

A new motor of streamlined appearance.

New G-E Polyphase Motor

★ **General Electric** announces an entire line of completely new polyphase induction motors, in integral horsepower sizes, to conform with new industrial trends, processes, and practices. Known as the **Tri-Clad motor** and representing one of the most extensive product changes in the history of the company, it has called for many new methods in G-E motor manufacturing.

In all its ratings it features modern streamlined appearance; more complete protection—through the use of a cast-iron frame—than heretofore available except in especially enclosed machines; major advances in the insulation of current-carrying parts; and improved bearing design and lubricating arrangements. At the same time, it incorporates the cast-aluminum rotor, pressure-relief system of greasing for ball-bearing motors, and other proven features.



A positioner for quantity production.

ALTER EGO: Literally "one's other self"—the still, small voice that questions, inspires and corrects our conscious action.

ALTER EGO: How many have offered you a "good-as-Fleetweld" rod . . . and are they confessing or bragging?

Well, here's the third different welding rod proposition that lays eloquent emphasis on the claim that it's as good as "Fleetweld." *That's stimulating.*

ALTER EGO: No, it's emulating. Emulation admires and strives to imitate great actions. It's a human trait.

That prompts me to ask myself—"Why is 'Fleetweld' taken as the standard of welding electrode comparison?"

ALTER EGO: Maybe Lincoln can give us the FACTS and we can judge for ourselves.

• •

LINCOLN SUGGESTS: To find out why "Fleetweld" is the standard of comparison for welding quality and economy, **TRY IT!** Compare it to other electrodes. In what ways? See the 30-Point Check Chart on Page 5 of the New "Weldirectory." This 56-page procedure guide (gratis) gives all the **FACTS** about 37 Lincoln Electrodes for welding and hard-surfacing—where to use them—how to use them—what weld properties to expect.

LINCOLN "SHIELD-ARC" WELDING THE LINCOLN ELECTRIC COMPANY Cleveland, Ohio

Largest Manufacturers of Arc Welding Equipment in the World

Strength of Spot Welds

(Concluded from page 31)

If we know the thickness of a sheet of metal, we are able to determine the number of spot welds of a certain diameter required to support a given load. It has been discovered that the angle of deformation starts at about one-third of the tensile strength of a weld; hence, one should never exceed a stress equal to one-third of the maximum load.

A factor of safety dependent upon the following consideration should be applied to all stresses:

Kind of load
Possibility of an accidental load
Danger to life and property

In any case, the factor of safety should always be four to six times the maximum allowable stress.

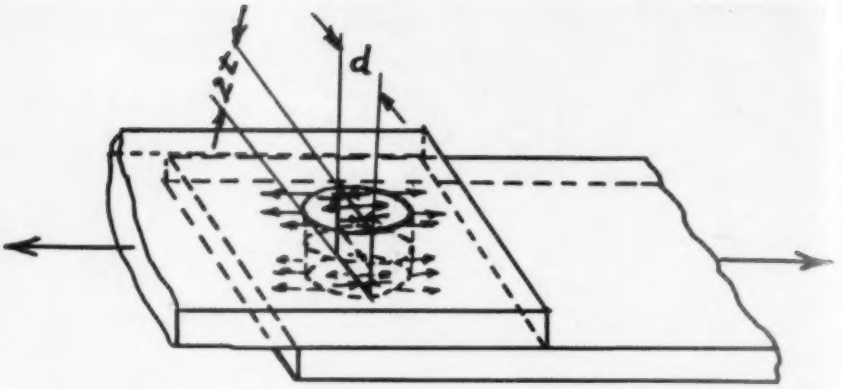


Figure 6—The direction of forces when a spot weld is placed in tension.

From analysis of welds and areas of metal resisting a parting force, we have derived the following formula for determining the strength of spot welds:

$$S = \frac{P}{2 \times t \times d \times N}$$

S = Stress in pounds per square inch.
P = Load in pounds.
t = Metal thickness of single sheet.
d = Mean diameter of spot weld button.
N = Number of welds.

For the sake of simplicity, we may take the value of 50,000 pounds per square inch as average for mild steel. Hence, our formula resolves itself into—P=100,000 x t x d.

» «

The Technical Slant

MAGNESIUM AND ITS ALLOYS. *By J. L. Haughton and W. E. Prytherch. Published by Chemical Publishing Co., New York, 1938. Cloth, 5½x8½ in., 100 pages. Price $1.50.*

This book is a monograph prepared from the results of investigations that have been in progress at the British National Physical Laboratory for the past five years. As such it probably represents the first fairly complete assemblage of facts to be published on magnesium and its alloys.

The book opens with data relative to the supply and production of this increasingly important light metal. Various manufacturing phases such as casting, forging, extrusion and heat-treating are discussed. Metallurgical data and the mechanical properties of magnesium and its alloys at room temperature and at elevated temperatures as well as constitution diagrams of binary and ternary magnesium alloys also form a part of this very interesting book.

Features which assure SUPERIOR WELDING QUALITIES of

TITAN BRONZE WELDING ALLOYS

Use of Purest Raw Materials Obtainable, such as Electrolytic Copper 99.96 in purity and Electrolytic Zinc 99.99 plus.

Strict Laboratory Control; Uniformity of Mixtures and Casting Temperature.

Double-Deoxidation Process which eliminates injurious gases.

Penn Bronze—is a general purpose rod. It is low melting (1620° F.) and tins easily and uniformly on galvanized, malleable or wrought iron as well as steel, brass, bronze and any other non-leaded metal with a melting point above 1850° F. It makes tough high-strength welds of high ductility, immune to strain hardening and with great abrasion and corrosion resistance.

Titan Manganese Bronze—is used where both hard and tough welds are desired. Although this is a general purpose rod, it is especially recommended for cast iron. It is free flowing and gives extremely dense, non-porous welds.

Titan Bronze—is a tin bronze with uses and characteristics similar to the manganese alloy; penetrates seams and crevices readily.

Submit your particular bronze-welding problem for solution by our engineers. Recommendations gladly forwarded, together with generous sample for trial in your own plant.

TITAN METAL MANUFACTURING CO.
Bellefonte, Pennsylvania

Military Preparedness

(Continued from page 23)

the end of his seam, against the "dam," with sound metal, that may be finished off without blow holes. He proceeds as follows: When the arc reaches the end of the seam, he shuts off the traverse feed: Within a few seconds he cuts the welding current down to one-half, and stops the wire feed. The arc will now lengthen, as the wire melts away, still further reducing the current, from the increased arc resistance, and causing the metal to "puddle" and flow on the surface. He quickly reduces the current to the last step and probably allows the arc to be extinguished by its increasing length.

The exact technique of manipulating these control buttons will differ somewhat with conditions of the job, but with this control it is possible for the welder to fill in his seam end with sound metal, and with any desired height of fill. Sometimes on difficult jobs, it may be necessary to shut off the arc for a few seconds, to allow the metal to cool slightly, starting up again for another few seconds to deposit metal in the deep crater, while it cools to hold its shape. These conditions frequently occur when very heavy currents are used. This sounds like a slow operation when described but an experienced operator will handle the stop and produce the effect within a few seconds.

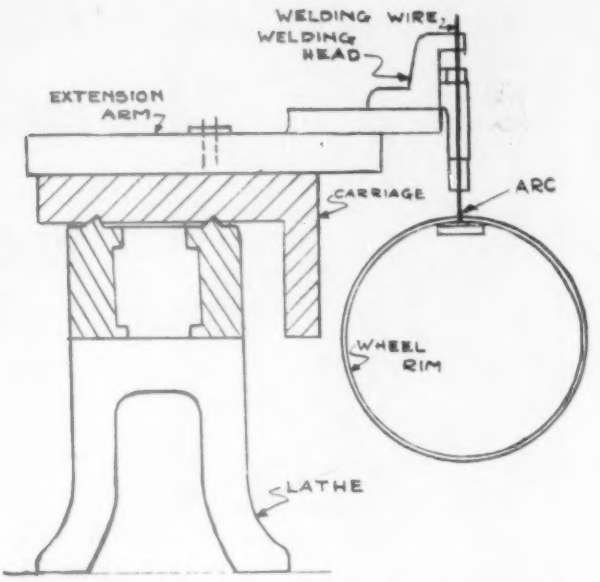


Figure 4—Sketch Showing Automatic Welding head mounted on an extensive bar on an old lathe carriage to traverse welding arc along seam.

Frequently such short seams (4 in.) are welded by hand. However, considering that there are about five thousand such seams to weld, also that the automatic feed guarantees a perfect weld, it would undoubtedly pay to arrange to do this work under the automatic.

After the rim is welded to the central disk, the spoke ribs are to

(Continued on page 44)

POSITION WELDING with the

New LOW-COST

2500 lb. (Capacity)

Ransome POSITIONER

Case histories in Ransome files reveal these important facts:

- Time and labor saving of from 30% to 50% on cylindrical, circular or odd shaped pieces.
- Welding rod saving of from 5% to 7% by less rod waste.
- More uniform, better and stronger welds.

The new 2500 lb. model is available for either hand or motor operation. The 32 inch square, all welded, T-slotted, table top tilts from horizontal to 45 degrees beyond vertical and revolves a full 360 degrees. Write for bulletin.

POSITIONERS ALSO AVAILABLE IN 1, 1½, 3 & 8 TON CAPACITIES

INDUSTRIAL DIVISION

RANSOME CONCRETE MACHINERY CO.

DUNELLEN, NEW JERSEY

W-3

SOLVE YOUR PRESSURE REDUCTION PROBLEMS

WITH

DOCKSON

SERIES "134"
WELDING & CUTTING

REGULATORS

•

DOUBLE STAGE
PERFORMANCE
SINGLE STAGE
CONSTRUCTION

•

SEE YOUR JOBBER OR WRITE

WELDING AND
CUTTING TORCHES
REGULATORS
ELECTRODE HOLDERS
HELMETS - GOGGLES
ACCESSORIES
FACE SHIELDS

DOCKSON Corporation
WELDING & SAFETY EQUIPMENT
3867 WABASH AVE. • DETROIT

Safe Practices

(Continued from page 36)

asbestos screen were provided but sparks flew under and beyond them.

The cardinal rule for safeguarding the use of portable equipment is to keep flames, sparks, molten slag and hot metal away from combustible material. Sweep floors clean and wet down wooden floors or cover them with sheet metal or other incombustible material. Floor and partition openings also must be covered. Before the weldor starts work, combustible goods or equipment should be moved at least 35 feet away. If they can not be moved, they should be protected against sparks by sheet asbestos, or sheet metal curtains or guards. Processes exposing combustible fibers or materials nearby should be shut down. Dust deposits and rubbish should be removed. It is unwise to use portable welding and cutting equipment in combustible buildings unless they are sprinklered and unless floors and partitions are tight. Instead, the work should be removed to the permanent welding shop.

Men with fire extinguishers should be stationed at the scene of all work done outside the welding shop. They should watch to see that sparks or drops of hot metal do not lodge in floor cracks, drop through openings or otherwise expose the property to the menace of fire. This watch service should be continued for half an hour after operations are finished, and floors above, below, and adjoining the work should be inspected.

The types of fire extinguishers to be used by the special watchmen will be determined by the class of fire that may be anticipated at a given point. Thus, if work were being done in the paint shop, where quantities of flammable liquids are exposed, the work can be safeguarded by extinguishers suitable for putting out "Class B" fires. If the welding and cutting were being done in the carpenter shop, or the shook and trim shop, extinguishers

(Continued on page 46)

Military Preparedness

(Concluded from page 43)

be welded on: This is a job of welding a straight fillet on each side of the ribs. It will be necessary to rig up means of traversing the welding head in a straight line, at a speed of the order of three or four feet per minute. The welding head is mounted on an extending arm overhanging the rim. The rim is then placed in suitable clamps, supported from the floor, and the arc adjusted as desired. Fixtures would have to be made to hold the wheel at a suitable angle, and be reversible for the other side of the spoke.

Taking the job as a whole, it will require more than ten miles of welded seam and about the same length of ¼ in. welding wire. This would require about 40 eight hour days, assuming an average of 3 feet per minute. Considering stops for one reason or another, probably the welding time would be nearer 70 than 40 days.

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Here — as in America's shops and factories and shipyards—G-R equipment helps to do the job RIGHT. Keeping pace with the industry's newest problems, G-R engineers now offer faster, easier-operating welding machinery for every phase of metal fabrication, from aircraft sheet metal to armor plate. There's no "bottleneck" here — WE'RE PREPARED to help solve YOUR welding problems . . . drop us a line.

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Flame Cutting Data — Hand and Machine

Table No. 1—Hand Flame Cutting Table for ⅛-In. to 12-In. Thickness For Clean Mild Steel—Not Preheated—Type No. 1 Cutting Only

Thickness of Steel, in.	Diameter of cutting Orifice, in.	Oxygen Pressure, lb. per sq. in.	Cutting Speed, in. per min.**	GAS CONSUMPTIONS*			
				Per Hour		Per Linear Foot**	
				Oxygen, cu. ft.	Acetylene, cu. ft.	Oxygen, cu. ft.	Acetylene, cu. ft.
⅛	0.0380-0.0400	15-23	20-30	45- 55	7- 9	0.37- 0.45	0.06-0.07
¼	0.0380-0.0595	11-20	16-26	50- 93	9-11	0.63- 0.72	0.08-0.11
⅜	0.0380-0.0595	17-25	15-24	60-115	10-12	0.80- 0.96	0.10-0.13
½	0.0465-0.0595	20-30	12-22	66-125	10-13	1.10- 1.14	0.12-0.17
¾	0.0465-0.0595	24-35	12-20	117-143	12-15	1.43- 1.95	0.15-0.20
1	0.0465-0.0595	28-40	9-18	130-160	13-16	1.78- 2.89	0.18-0.29
1½	0.0595-0.0810	-40	6-				
2	0.0670-0.0810	22-50	6-13	185-231	16-20	3.55- 6.16	0.31-0.53
3	0.0670-0.0810	33-55	4-10	240-290	19-23	5.80- 12.00	0.46-0.95
4	0.0810-0.0860	42-60	4- 8	293-388	21-26	9.70- 14.64	0.65-1.05
5	0.0810-0.0860	53-70	3.5- 6.4	347-437	24-29	13.66- 19.83	0.91-1.37
6	0.0980-0.0995	45-80	3.0- 5.4	400-567	27-32	21.00- 26.70	1.19-1.80
8	-0.0995	60-77	2.6- 4.2	505-615	31-5-38.5	29.30- 38.84	1.83-2.42
10	-0.0995	75-96	1.9- 3.2	610-750	36.9-45.1	46.90- 64.20	2.57-3.84
12***	.1200	69-86	1.4- 2.6	720-880	42.3-51.7	67.70-103.00	3.98-6.05

*As the pressure of acetylene for the preheating flames is more a function of blowpipe or torch design than of the thickness of the part being cut, the pressure data, therefore, have been omitted from this table. For acetylene pressure data, see cutting apparatus manufacturers' charts.

**Lowest speeds and highest gas consumptions per linear foot are for inexperienced operators, short cuts, dirty or poor material. Highest speeds and lowest gas consumptions per linear foot are for experienced operators long cuts, clean and good material.

***Beyond 12-in. thickness, the critical data of manual cutting practices are greatly affected by the condition of the metal and the skill of the operator, resulting in wide ranges of data. In view of this, the table has been terminated at the 12-in. thickness.

The reader is referred to Table No. 2, below, giving data on Machine Cutting wherein the thickness range has been extended to 20 in.

Table No. 2—Machine Flame Cutting Table for ⅛-In. to 20-In. Thickness For Mild Steel—Not Preheated—Type No. 1 Cutting Only***

Thickness of Steel, in.	Diameter of cutting Orifice, in.	Oxygen Pressure, lb. per sq. in.	Cutting Speed, in. per min.**	GAS CONSUMPTIONS*			
				Per Hour		Per Linear Foot**	
				Oxygen, cu. ft.	Acetylene, cu. ft.	Oxygen, cu. ft.	Acetylene, cu. ft.
⅛	0.0250-0.0400	15- 23	22-32	40- 55	7- 9	0.34- 0.36	0.05- 0.06
¼	0.0310-0.0595	11- 35	20-28	45- 93	8-11	0.45- 0.66	0.07- 0.08
⅜	0.0310-0.0595	17- 40	19-26	82- 115	9-12	0.86- 0.89	0.09- 0.09
½	0.0310-0.0595	20- 55	17-24	105- 125	10-13	1.04- 1.24	0.11- 0.12
¾	0.0380-0.0595	24- 50	15-22	117- 159	12-15	1.45- 1.56	0.14- 0.16
1	0.0465-0.0595	28- 55	14-19	130- 174	13-16	1.83- 1.86	0.17- 0.19
1½	0.0670-0.0810	- 55	12-15	- 240	14-18	3.20-	0.23- 0.24
2	0.0670-0.0810	22- 60	10-14	185- 260	16-20	3.70- 3.72	0.29- 0.32
3	0.0810-0.0860	33- 50	8-11	240- 332	18-23	6.00- 6.04	0.42- 0.45
4	0.0810-0.0860	42- 60	6.5- 9	293- 384	21-26	8.53- 9.02	0.58- 0.65
5	0.0810-0.0860	53- 65	5.5- 7.5	347- 411	23-29	10.97- 12.62	0.77- 0.84
6	0.0980-0.0995	45- 65	4.5- 6.5	400- 490	26-32	15.10- 17.78	0.98- 1.16
8	0.0980-0.0995	60- 90	3.7- 4.9	505- 625	31-39	25.52- 27.30	1.59- 1.68
10	0.0995-0.1100	75- 90	2.9- 4.0	610- 750	37-45	37.50- 42.10	2.25- 2.55
12	0.0110-0.1200	69-105	2.4- 3.5	720- 880	42-52	49.70- 60.00	2.97- 3.50
14	0.0110-0.1200	-105	2.0- 3.2	830-1045	48-59	65.20- 83.00	3.69- 4.80
16	0.1285-0.1600	-110	1.8- 3.0	935-1360	57-70	90.60-104.00	4.67- 6.33
18	0.1495-0.1600	-120	1.7- 3.0	1045-1680	65-83	112.10-123.00	5.53- 7.65
20	0.1610-0.2000	-135	1.5- 3.0	1155-2050	75-99	136.70-154.00	6.60-10.00

*As the pressure of acetylene for the preheating flames is more a function of blowpipe or torch design than of the thickness of the part being cut, the pressure data, therefore, have been omitted from this table. For acetylene pressure data, see cutting apparatus manufacturers' charts.

**Lowest speeds and highest gas consumptions per linear foot are for inexperienced operators, short cuts, dirty or poor material. Highest speeds and lowest gas consumptions per linear foot are for experienced operators long cuts, clean and good material.

***The apparent inconsistencies which will be noted in some of the columns in the table are due to the fact that there does not exist a straight-line relationship between the elements of pressure, speed and orifice sizes for the range of apparatus data from which this table was devised.

(Courtesy International Acetylene Association)

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News of the Industry

Civil Service Examinations—Inspectors of Supplies Needed for War Department

The United States Civil Service Commission is endeavoring to secure inspectors of miscellaneous supplies to fill positions at the Jeffersonville Quartermaster Depot, Jeffersonville, Indiana.

Inspectors are needed in the following classes of supplies: Hardware, leather, wood products, chinaware and glassware, stoves and ranges, tents, sheet metals and sheet-metal products, bakery and cafeteria equipment, tableware and kitchen utensils, paints, varnishes, shellac, lacquers, etc., and gasolines, greases, lubricating oils, etc. The salary for these positions ranges from $1,800 to $2,000 a year, less a retirement deduction of 3½ percent.

Applications may be filed with the Secretary, Board of U. S. Civil Service Examiners, U. S. Engineer Department at Large and Jeffersonville Quartermaster Depot, Louisville, Kentucky, until further notice. In view of the great demand for qualified persons, applicants are urged to file their applications promptly.

Applicants must have completed a 4-year high-school course, except that they may substitute additional inspectional or testing experience for this requirement. In addition, they must have had 4 years of experience in the inspection or testing of one or more of the classes of supplies listed above. Each year of college study in appropriate engineering courses may be substituted for each 6 months of this experience. Applicants will not be given a written test, but will be rated on their qualifications as shown in their applications and on corroborative evidence.

Further information regarding the examination may be obtained from the Secretary of the Board of U. S. Civil Service Examiners at the post office or customhouse in any city which has a post office of the first- or second-class, or from the United States Civil Service Commission, Washington, D. C.

Safe Practices

(Concluded from page 44)

suitable for "Class A" fires would be required. This is a phase of the work the fire chief should supervise and the types of extinguishers might well be specified on the permit. It is recommended that a stock of extra fire extinguishers be made available so it will not be necessary to remove extinguishers from their usual stations throughout the plant.

Needless to say, the special watchmen should know how to handle the extinguishers, and also how to lay lines of small hose. These precautions, valuable at all times, are of particular importance in the current emergency, when delay caused by a serious fire may assume national significance.

Chemical Society Meeting

Chicago will be the chemical capital of the world December 11 to 15 with the holding of the first biennial **National Chemical Exposition** and **Industrial Chemical Conference** at the Stevens Hotel under the auspices of the Chicago Section of the American Chemical Society.

More than 20,000 are expected to come from all sections of the country to view the show and participate in the conference which will be addressed by noted authorities including **Gustav Egloff** of Chicago, who has been cited many times

The Improved "Round File" Gas Lighter

The "Round File" construction provides a very large file area — *approximately one square inch.* This assures longer life for the lighter. The file is of superior quality and can be easily replaced.

Many superior design and construction features combine to make the Improved "Round File" the most economical and efficient lighter on the market. Get acquainted with Improved "Round File" and its many advantages.

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SAFETY GAS LIGHTER CO. (Est. 1901) **LYNN, MASS.**

by the American Chemical Society for his contributions to the science of chemistry. One of the world's most noted petroleum chemists, Mr. Egloff is the author of many books on the subject. He will talk on the "Service of Chemistry to Industry."

Added significance will be given the show and conference because of the vital part chemists are destined to take in the program for national defense.

Personals

A. J. Mealey has been appointed sales manager of the **Commercial Gas Co.**, Minneapolis, Minn., effective October 15, 1940. Mr. Mealey takes over his new duties after spending six years as sales representative for the Commercial Gas Co. and Smith Welding Equipment Corp. For the past three years Mr. Mealey has been in charge of the Pacific-Northwest territory and prior to that he has handled territories in Montana, Missouri and Kansas.

» «

J. E. Haseltine & Co., 2nd and Ash Ave., Portland, Ore., announce the opening of a branch warehouse and salesroom at 510 First St. South, Seattle. This branch, which will be managed by **Mr. J. H. Tadlock**, will carry a complete stock of welding equipment supplies and accessories covering the various lines represented by the J. E. Haseltine & Co.

» «

Carniegie-Illinois Steel Corp. announces that **Charles F. Dickson** has been appointed as manager of the sheet and strip bureau, metallurgical division, Chicago. He succeeds **Maurice B. Sunderland**, who has been transferred to the Pittsburgh office as metallurgical engineer handling sheet and strip. Mr. Dickinson was formerly assistant to the general superintendent of the Gary sheet and tin mills. **Paul R. Lawrence**, who has been manager of the tin plate bureau, metallurgical division, Chicago, since 1936 will become assistant to the general superintendent of the Gary sheet and tin mills succeeding Mr. Dickinson.

Charles H. Jackman becomes manager of the structural and plate bureau, metallurgical division, Chicago, the position formerly held by **Earl H. Davidson**, who goes to Pittsburgh as metallurgical engineer, handling structural and plate. Mr. Jackman has been a Chicago contact representative of this bureau since 1936.

John N. Crombie has been made manager of the tin plate bureau, metallurgical division, Chicago, after serving as contact representative of this bureau for four years.

Elmer Gammeter becomes manager of the stainless steel bureau, metallurgical division, Chicago. He has been contact representative since 1937.

Obituary

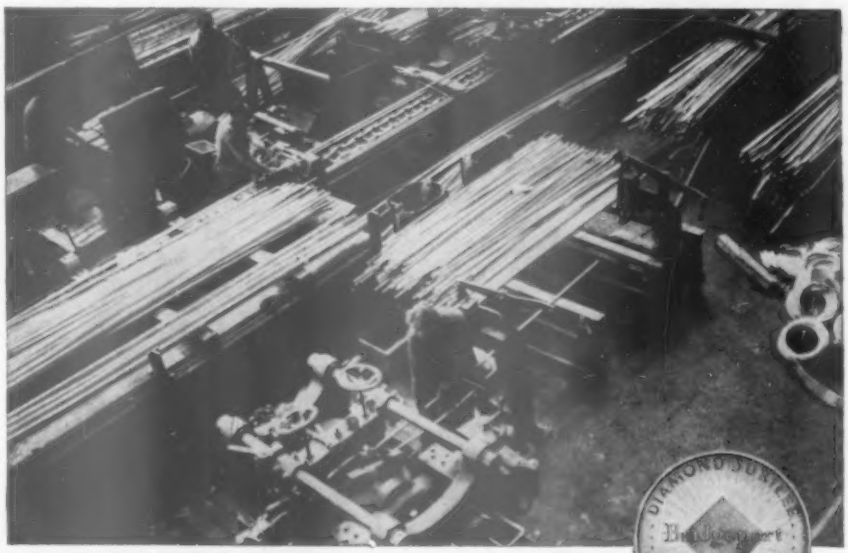
Frank B. Hamerly of Aurora, vice president of the Independent Pneumatic Tool Co. of Chicago, died November 27th of a heart attack while inspecting the company's plant at Los Angeles, Cal. Mr. Hamerly was 53 years old.

» «

Sir Robert Hadfield, 82, internationally known engineer and metallurgist, died in London, England, September 30. Sir Robert, who was chairman of Hadfields, Ltd., Sheffield, Eng., was the inventor of silicon steel, manganese steel and many other alloys and metallurgical improvements. His inventions, which have been estimated to have saved the world $4,000,000,000 to date, resulted in his being honored by many foreign governments and scientific societies.

» «

Death came to **Charles L. Allen**, 82, on November 4 at his home in Worcester, Mass., thus bringing to a close the colorful career that was marked by 59 years of associations with the Norton Company. Mr. Allen, who was Chairman of the Board at the time of his death, joined the F. B. Norton Company, a concern manufacturing pottery ware, as bookkeeper in 1881. In 1885 when the Norton Emery Wheel Company was organized, he became its general manager and continued in this capacity



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Charles L. Allen

through the various successor companies until 1933 at which time he became Chairman of the Board of the Norton Company. He was made secretary and director of the Norton Emery Wheel Company in 1892 and in 1912 upon becoming treasurer, relinquished his secretaryship. When the Norton Company was founded in 1919, Mr. Allen was elected President.

Mr. Allen proved himself to be one of the most public spirited citizens of Worcester and despite his business responsibilities, was never too busy to devote untiring efforts to the promotion of civic activities in that city. He was a member of the St. Lawrence Waterways Commission, and in 1931 was decorated with an honorary medal by the King of Sweden for the aid that he had given to the Swedish immigrants to America.

Current Reviews

Cutting Machine Booklet

A new 8-page booklet has just been published by **Air Reduction,** New York, featuring the **No. 4 Radiagraph**—a Portable Motor-Driven Gas Cutting Machine. The first four pages are devoted to a discussion of the general operation and construction features. This section points out how the machine is ideal for making straight line cuts, for cutting arcs or complete circles and for cutting irregular shapes involving long sweeping curves, either simple or compound. Such operations can be performed with accuracy when making either square or bevel edges.

The second half of the book is devoted to a description of flame hardening and plate edge preparation operations which can be accomplished by using the Standard No. 4 Radiagraph with special, easy-to-attach equipment. Copies of this bulletin may be had by writing Air Reduction, 40 East 42nd St., New York.

» «

Welding and Cutting Bulletin

★ **"Dockson Welding and Cutting Equipment"** is the title of a new 4 page folder just published by the **Dockson Corp.,** 3801 Wabash Ave., Detroit. Known as **Bulletin 1040-A,** this folder illustrates and describes the complete Dockson line of welding and cutting torches, regulators and complete gas welding and cutting outfits. Copies of Bulletin 1040-A will be furnished upon request by the Dockson Corp.

» «

Welding Machine Data Booklet

★ A new 12 page illustrated booklet giving valuable facts about welders and their operation is announced by the Westinghouse Electric & Manufacturing Co. Covered in the booklet are motor and engine driven welders, and bare welding generators.

Information contained includes dimensions, weights, and ratings for various types of machines. Application for each type is discussed, and a general description of each provided. Features of the "Flexarc" welder construction are explained, with photographs and cutaway sketches to aid the reader.

Fourteen characteristic curves, covering all the general types, are a feature of this booklet, and give interesting data on welder operation. Complete gasoline engine specifications for welder prime movers are given. Optional and standard

★ *MILBURN "TWIN STAGE" REGULATOR*

A TWO STAGE BALL SEAT

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equipment are discussed, and on the last page there is a summary of the distinctive features and advantages of the "Flexarc" line—each with a brief explanatory sentence.

Copies of **Descriptive Data 26-100** may be obtained upon request from Dept. 7-N-20, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

» «

Electrode and Die Catalog

The **Electroloy Co., Inc.**, 1600 Seaview Ave., Bridgeport, Conn., have recently issued a catalog of **Electroloy Alloys** for Resistance Welding Electrodes and Dies. Included as a part of this 36 page catalog is complete information and technical data on typical physical properties necessary for manufacturers and users of welding equipment for spot welding, seam welding, flash, butt and projection welding. Prices on finished electrodes and bar stack are also given.

» «

Metal Shaping Machine Catalog

Continental Machines, Inc., of Minneapolis, Minn., have prepared comprehensive brochures describing in detail the **DOALL Contour metal shaping machines** manufactured by them.

Each book contains detailed specifications of the various DOALL models manufactured by the company. These machines built for continuous sawing, filing and polishing, are available in various sizes and capacities, to meet the demands of all industries. It is claimed the most intricate of jobs to the largest of aircraft or shipbuilding parts are accommodated on these machines, so the details of each model are prepared for the specific industries where they will have the greatest applications.

A complete catalogue has been published by the company that is available for all government activities. It contains all of the data sheets and detailed government specifications that are required for the writing of bids. These brochures contain the complete descriptions of the machines manufactured by the company and are available to manufacturers requesting same on business letterhead.

» «

New Literature on Portable Gas Cutting Machine

The New No. 10 Radiagraph Bulletin just published by **Air Reduction Sales Co.**, New York, discusses in detail, this lightweight motor-driven gas cutting machine. The scope of the standard machine includes cutting straight lines of any length using a track; cutting circles from 3 to 85 inches in diameter; cutting arcs up to a radius of 42½ inches and irregular outlines by manual operation to a limited degree. In any of these operations, cuts can be made having either square or beveled edges. Features of construction are outlined in detail.

The second half of this booklet is devoted to the additional practical cutting operations which can be accomplished with the No. 10 Radiagraph when equipped with simple, easy-to-attach accessory equipment. With these attachments this machine is readily adaptable for plate edge preparation; for making parallel cuts—either circular or straight lines; for structural shape cutting—both channel iron and I-beams and H-beams and for templet cutting of oval, square or other contours. For each of the special operations, the additional material required to be used with the standard No. 10 Radiagraph, is listed together with a manufacturer's stock numbers to facilitate ordering.

Copies of this bulletin and additional material desired may be had by writing Air Reduction, 60 East 42nd Street, New York.

Stainless Clad Steel Manual

★ The most recent advances in the methods of fabricating and welding stainless clad steel are to be found in a new booklet just issued by **Ingersoll Steel & Disc Division,** Borg-Warner Corp., 310 South Michigan Ave., Chicago. This latest 16 page booklet bears the same title as earlier editions—**"Manual of Welding and Fabricating Procedures for IngAclad Stainless Clad Steel."**

It differs from the previous editions in that it is entirely new in form and in presentation with a complete revision text and diagrams illustrating welding and fabricating procedures. Improve-

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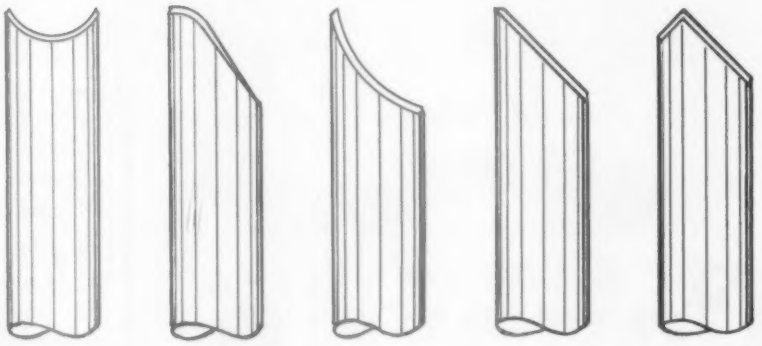

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ments in technique to assure the maximum strength, corrosion resistance and ductility in welded fabrication have been emphasized.

Fabricators and users of corrosion resisting alloys will find many phases of forming, bending, welding, heat treating, cleaning, grinding and polishing of stainless clad steel covered in the booklet.

Featured in the manual is a chart showing the corrosion resistance of two types of IngAclad to a long list of acids, alkalis and various corrosive liquids and materials in common usage.

In addition to descriptions and diagrams of procedures the booklet is well illustrated with applications of IngAclad in the food, chemical, paper, and many other process industries as well as showing many applications for polished IngAclad sheets in drug stores, restaurants, institutions, etc.

» «

Alloy Booklet

The ability of Ampco Metal to safeguard the vital points in industry's outstanding mechanical equipment is described in **"Brief Facts About Ampco Metal,"** a 16-page illustrated booklet just issued by **Ampco Metal, Inc.,** Milwaukee, Wis.

This copper, high-aluminum, high-iron alloy is used as a material for bushings, bearings, gears, and similar applications where long life and resistance to wear are important.

The six grades and modifications of Ampco are described and illustrated by photomicrographs. The importance of Ampco's very complete laboratory and testing equipment in the control and process of producing the aluminum bronze metal is emphasized. Space is devoted to Ampco Rotocasting—the improved centrifugal casting method which is achieving new importance in casting special shapes centrifugally. Ampco's importance as a corrosion- and acid-resistant material is discussed. The booklet contains much pertinent Ampco information.

Copies will be sent to interested executives on request.

» «

Gas Cutting Machine Bulletin

A 24-page bulletin featuring the No. 6-A Oxygraph and the Nos. 10, 40, and 41 Travographs has just been published by Air Reduction, New York. These machines will cut an unlimited variety of shapes from steel plate, slabs, billets and forgings. Pages 4 to 13 in this interesting booklet are devoted to excellent examples of the "Visible Evidence of the Scope and Cost-Paring Possibilities" of this group of Airco Gas Cutting Machines.

All operate on the pantograph principle so that one or several cutting torches are made to conform exactly to the movement of the tracing device. The second half of the book is devoted to an individual treatment of each of the machines discussed therein. Features of construction and operation are discussed in detail, standard equipment and electrical requirements are listed. The last two pages are devoted to an interesting treatise giving many helpful hints for machine gas cutting. This material includes an approximate guide for Airco machine gas cutting, with suggested tip sizes, oxygen and acetylene pressures, cutting speed in inches per minute and approximate gas consumption.

Additional information and a copy and bulletin may be obtained by writing Air Reduction, 60 East 42nd St., New York.

Recent Patents

Spot Welding

2,220,394. **Harry R. Canfield,** Cleveland, Ohio, assigned to **The Clark Controller Co.,** Cleveland, Ohio. Filed Feb. 20, 1939. Issued Nov. 5, 1940. A welding system is shown which includes a fluid-pressure operated contactor for timing the welding current; an element for introducing a delay time interval between successive welds; mechanism for introducing a cold-hold time interval after each weld; and control elements for proper correlation of these mechanisms.

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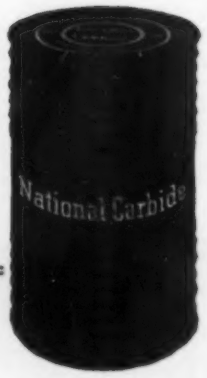

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Cast-Iron Flux No. 1; Brazing Flux No. 2; "Braz-Cast" Flux No. 4 (for bronze welding cast-iron); Aluminum Fluxes Nos. 5 and 8; Stainless Steel Flux No. 9; Silver Solder Flux No. 10; Tinning Flux No. 11.
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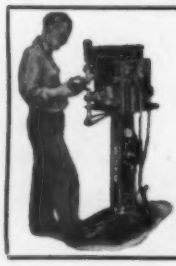

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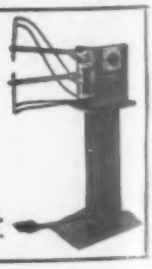

Arc Welding

2,220,576. **Meredith H. MacKusick,** Fairlawn, Ohio, assigned to **The Babcock & Wilcox Co.,** Newark, N. J. Filed Aug. 13, 1938. Issued Nov. 5, 1940. Broadly this invention relates to a method of welded in which a bare weldrod is disposed within, or at least partially within a narrow welding groove in the work piece and temporarily insulated from the work piece by means consumed by the arc as it deposits the metal of the weldrod. During the welding operation, the arc and resultant metal pool are entirely hidden from view and completely shielded by a smothering agency which in addition to positively excluding oxygen and nitrogen of the air, conceals the arc so as to do away with the necessity for unusual protection of the operator's eyes. The process yields a crack-free weld; and a welding speed of 60 to 100 feet per hour is claimed for the new method. The arc smothering material is a mixture of asbestos, ferro manganese, silica, magnetic iron oxide and manganese dioxide. In the process, the work and the strip of weld rod within the groove are included in a welding circuit. An arc is promoted between an end of the strip and the work whereby the strip is progressively deposited with an arc confined substantially to the area of the end of the welding strip. An electric terminal moves along the weld strip through the fluxing material to form the weld. The method is shown with particular application to the welding of circular metal drums.

» «

Weld Rod Coating

2,220,954. **Edward C. Chapman,** Lookout Mountain, Tenn., assigned to **Combustion Engineering Co., Inc.,** New York. Filed Dec. 9, 1939. Issued Nov. 12, 1940. A weld rod coating composed of the following materials in the ranges indicated in parts by weight; potassium feldspar, 7-15; organic material, 2-10; calcium carbonate, 4-10; clay, 4-10; ferromanganese, 4-10; sodium silicate, 10-25; and titanium dioxide, 30-50.

» «

Weldable Steel

2,218,888. **Alessandro Marchetti,** Sesto Calende, Italy. Filed May 24, 1939. Issued Oct. 22, 1940. This patent is concerned with a high resistance steel alloy which can be used to fabricate structures such as aircraft, ships, railways, automobiles and the like without having to normalize and heat-treat the welded construction. The alloy consists of .16 to .18% carbon, 1.2 to 1.5% manganese, 0.10 to 0.30% silicon, .6 to 1% chromium, .3 to 1% molybdenum, .3 to .8% vanadium and the remainder substantially all iron.

» «

Butt-Welding Machine

2,219,279. **Emeric Gaspar,** London, Eng., assigned to **Omes Limited,** Barnes, London, Eng. Filed June 30, 1939. Issued Oct. 29, 1940. A combined butt-welding and forging device is described in this patent. The machine includes a bed, two vice electrodes, two feed devices one for preliminary moving one vice electrode and the other a heavy-pressure feeder provided with a ram to engage the ends of workpieces to force them through the second electrode for upsetting and welding operations. A regulatable transformer is connected to the electrodes, the voltage variation of which is adequate to enable it to suit both welding and forging operations.

» «

Fusion Lining

2,219,352. **Orrin E. Andrus,** Milwaukee, Wis., assigned to **A. O. Smith Corp.,** Milwaukee, Wis. Filed Feb. 13, 1937. Issued Oct. 29, 1940. A new process of lining vessels such as oil refinery vessels with alloy steels is based upon the discovery that chromium and nickel alloy steels normally resistant to corrosion can be readily fusion welded to a base plate of steel. The welding is carried out by a process which comprises placing the alloy sheet in contact with the base plate, placing over the alloy sheet a perforated metal plate, inserting a flux material in the perforations and establishing and maintaining an electric arm through a molten body of flux in each perforation to melt the alloy sheet and weld it to the base metal. The process is suitable for spot or line welding. The

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material may be sodium chloride for welding stainless steels. Borax and sodium silicate may also be employed. Sufficient powdered flux should be employed to provide a molten flux bath about one-half inch in depth. The electrode may be either a metal rod or a carbon pencil.

» «

Welding Rod

2,219,462. **William A. Wissler,** Niagara Falls, N. Y., assigned to **Haynes Stellite Co.,** of Indiana. Filed Mar. 11, 1938. Issued Oct. 29, 1940. An unsintered welding rod containing a binder and ingredients at least a substantial part of which are comminuted and unalloyed with the remainder of the ingredients. The ingredients are so chosen and proportioned that the rod when used for fusion welding produces a deposit having 12 to 75% of at least one metal of the group of chromium, tungsten, molybdenum, columbium, and tantalum, and the remainder principally cobalt, nickel, or iron, together with carbon in an amount not exceeding 4%. The iron content does not exceed 25%. The rod is stated to produce sound substantially homogeneous deposits.

» «

Welding Thin Steel

2,219,493. **Ed Reed,** Zanesville, Ohio, assigned to **The American Rolling Mill Co.,** Middleton, Ohio. Filed June 6, 1938. Issued Oct. 29, 1940. There is described an apparatus for butt-welding thin silicon steel in such a manner as to produce a weld which is not substantially thicker, if at all, than the gauge of the steel strips.

» «

Tubular Welding

2,219,599. **Vincent S. Penote,** Euclid, Ohio. Filed Oct. 1, 1938. Issued Oct. 29, 1940. This invention relates to an improved method of joining rods, tubes, bars or the like together, and more particularly to a method of welding one member such as a tube to another member, with the end of one member abutting the side surface of the other, so as to form a tee. The method involves using straight cut tube ends. According to the new method there is placed against one side of one of the tubes a flanged member having comparatively straight longitudinal edges, the edges being in longitudinal contact with the tube. This flanged member is welded along the edges to the tube wall. The flat cut end of the other tube is then placed in an abutting position against the flat outer face of the flanged member and is welded to that face. A number of tubular members may be welded to the flat outer face. Moreover, instead of one flat outer face, there may be two flat faces onto which abutting tubes can be welded. The use of the intermediate flanged member avoids the necessity of cutting the end of the abutting tube with a contour which would fit the side wall of the first tube.

Welding Wire

2,219,817. **Samuel G. Negrich,** Detroit, Mich. Filed Sept. 22, 1939. Issued Oct. 29, 1940. To increase the firmness with which a welding wire may be held, and to materially reduce heating at the point of holding and increase the heat at the working end of the wire, this inventor has provided a new wire shape. According to the patent, the body of the wire is simply flattened to provide grip surfaces on opposite sides. At each end of the flattened portions, there are shoulders where the flat surfaces merge into the cylindrical body of the wire. For a common type of holder, which has parallel jaws, a wire is used which has parallel flattened sides. Where the jaws do not close in substantially parallel relation, the wire may be flattened so that the flat sides converge toward each other to provide a firm grip in the jaws of the holder. As distinguished from substantially point contact obtained in the method of holding a round wire, a marked freedom from heating of the holder and a much hotter welding heat at the working end of the wire is claimed for this new wire. The shoulders prevent endwise movement of the wire between the jaws, such as when the end of the wire is tapped on a solid surface for the purpose of clearing the point of the wire. The use of this wire permits the utilization of simple and inexpensive holders.

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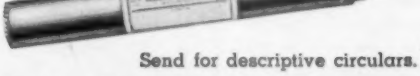

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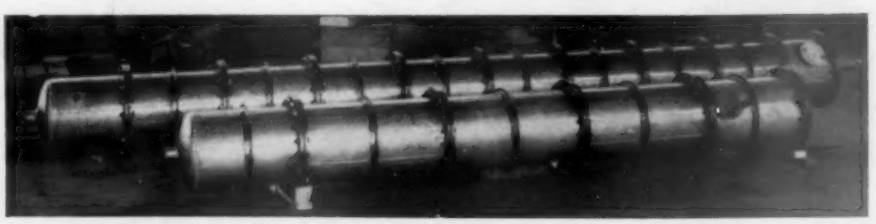

Welded copper stripping and rectifying columns. Photo (Leader Iron Works, Inc.).

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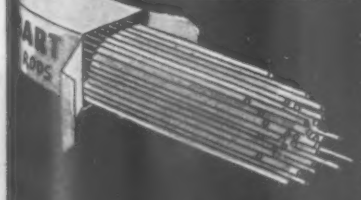

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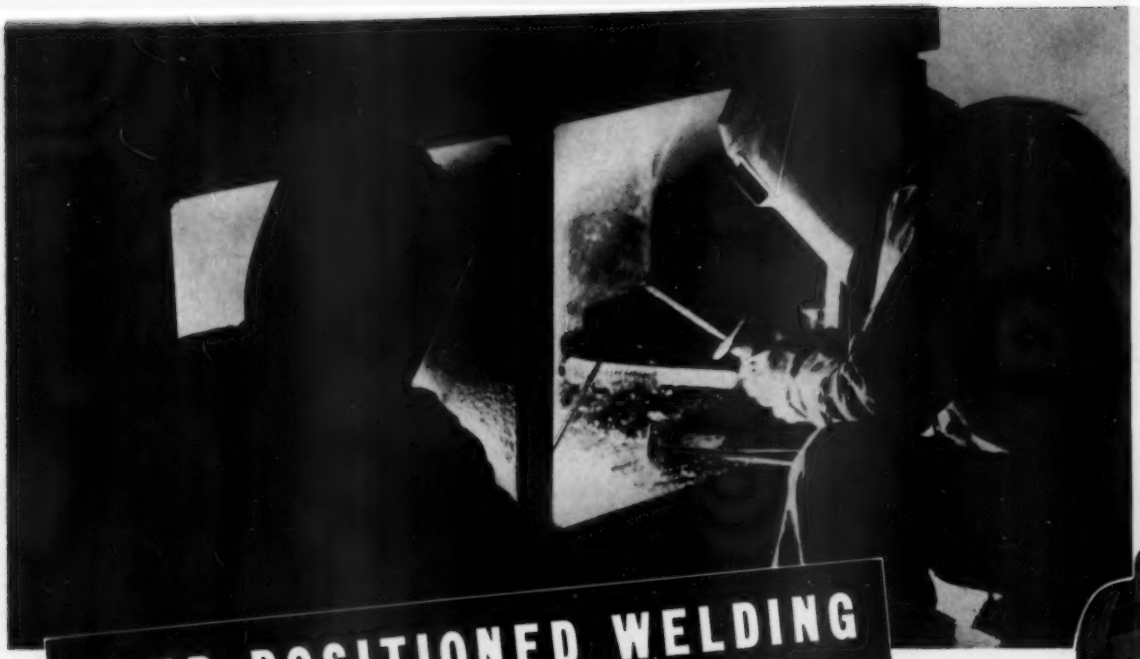

Type FHP welds stand the gaff in equipment such as these ingot stripping tongs made by Shaw-Box Crane & Hoist Co., Muskegon, Mich.

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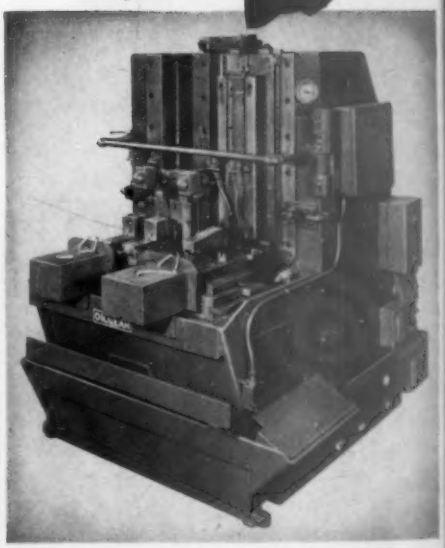

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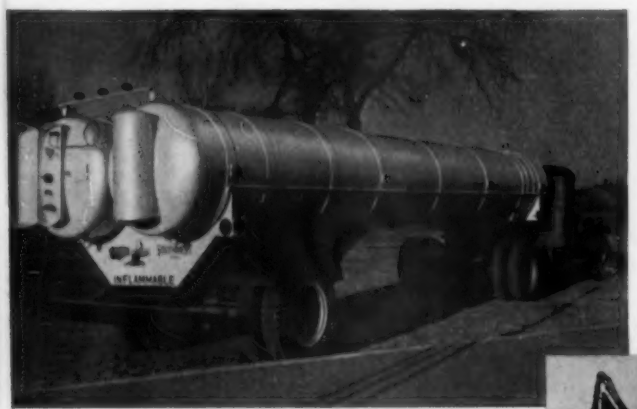

Welders qualify readily with Type FHP for code welded work like the building of this butane transport tank, made by Southwest Factory, Oklahoma City.

Investigate Thermit Welding, too—in use since 1902 for heavy repair work, crankshafts, etc.

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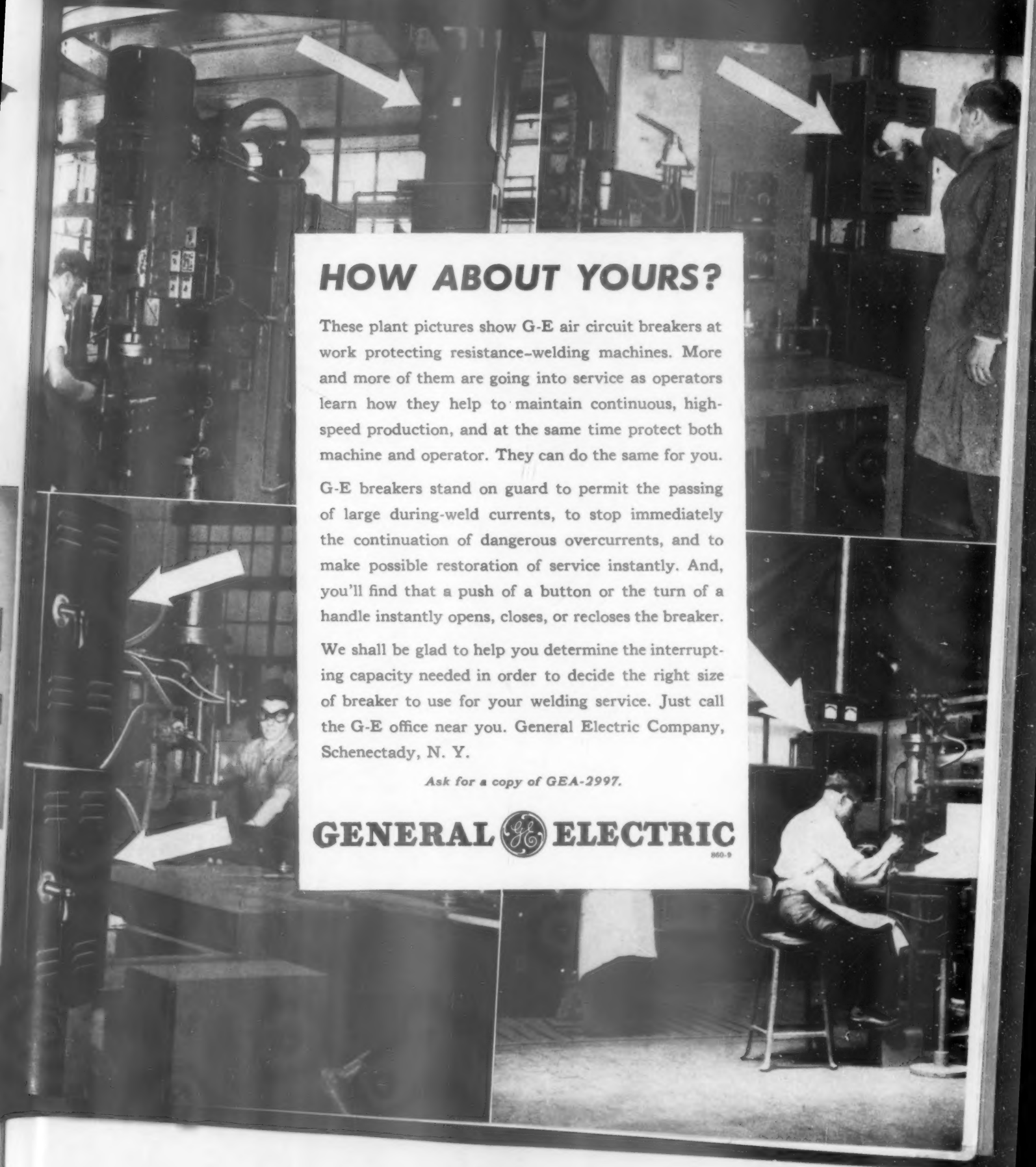

HOW ABOUT YOURS?

These plant pictures show G-E air circuit breakers at work protecting resistance-welding machines. More and more of them are going into service as operators learn how they help to maintain continuous, high-speed production, and at the same time protect both machine and operator. They can do the same for you.

G-E breakers stand on guard to permit the passing of large during-weld currents, to stop immediately the continuation of dangerous overcurrents, and to make possible restoration of service instantly. And, you'll find that a push of a button or the turn of a handle instantly opens, closes, or recloses the breaker.

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Ask for a copy of GEA-2997.

GENERAL ELECTRIC

860-9

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Low Pressure • Equal Pressure
Manufactured or Natural Gas

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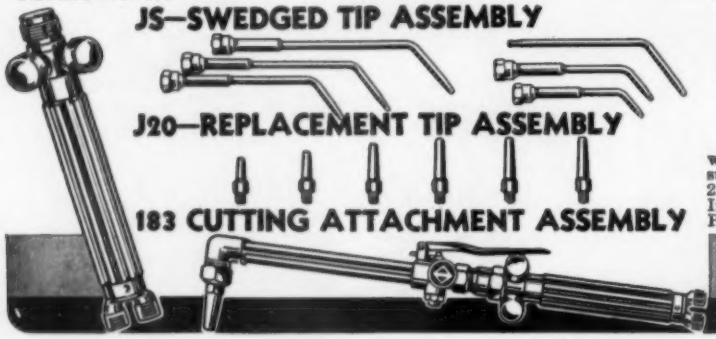

Welding flame automatically shuts off as hold on torch is released, saving gases otherwise wasted between welds. When operator is again ready to weld, torch is instantly brought back to full flame—no relighting, no readjusting of torch. Tests show average gas savings per man of $4.80 per day and increased production of from 100% to 148%. Weight 13 oz., length including tip 14½", tip size No. 1 thru No. 8. Price $24.00 at Detroit, tips extra $1.00 each. Model W is same torch without lever lock, priced at $23.00.
TWO WEEKS FREE TRIAL.

Hang idle torch on Gasaver, weight of torch pulls down lever rod shutting off supply lines. Cuts oxygen-acetylene consumption 25 to 30%. To relight pass torch over pilot flame. Install on line between regulators and torch. Price $10.00 at Detroit, two weeks trial free.

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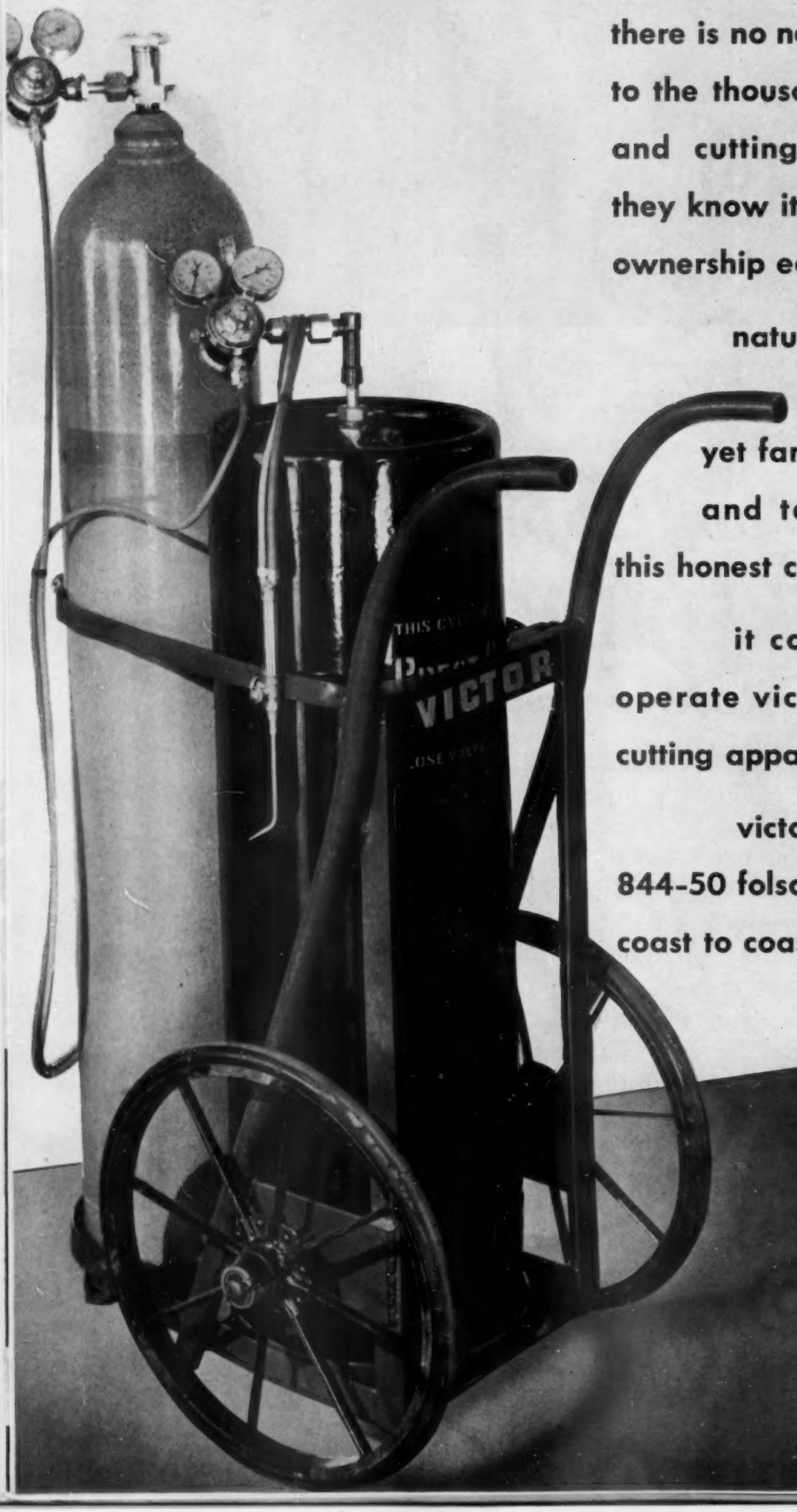

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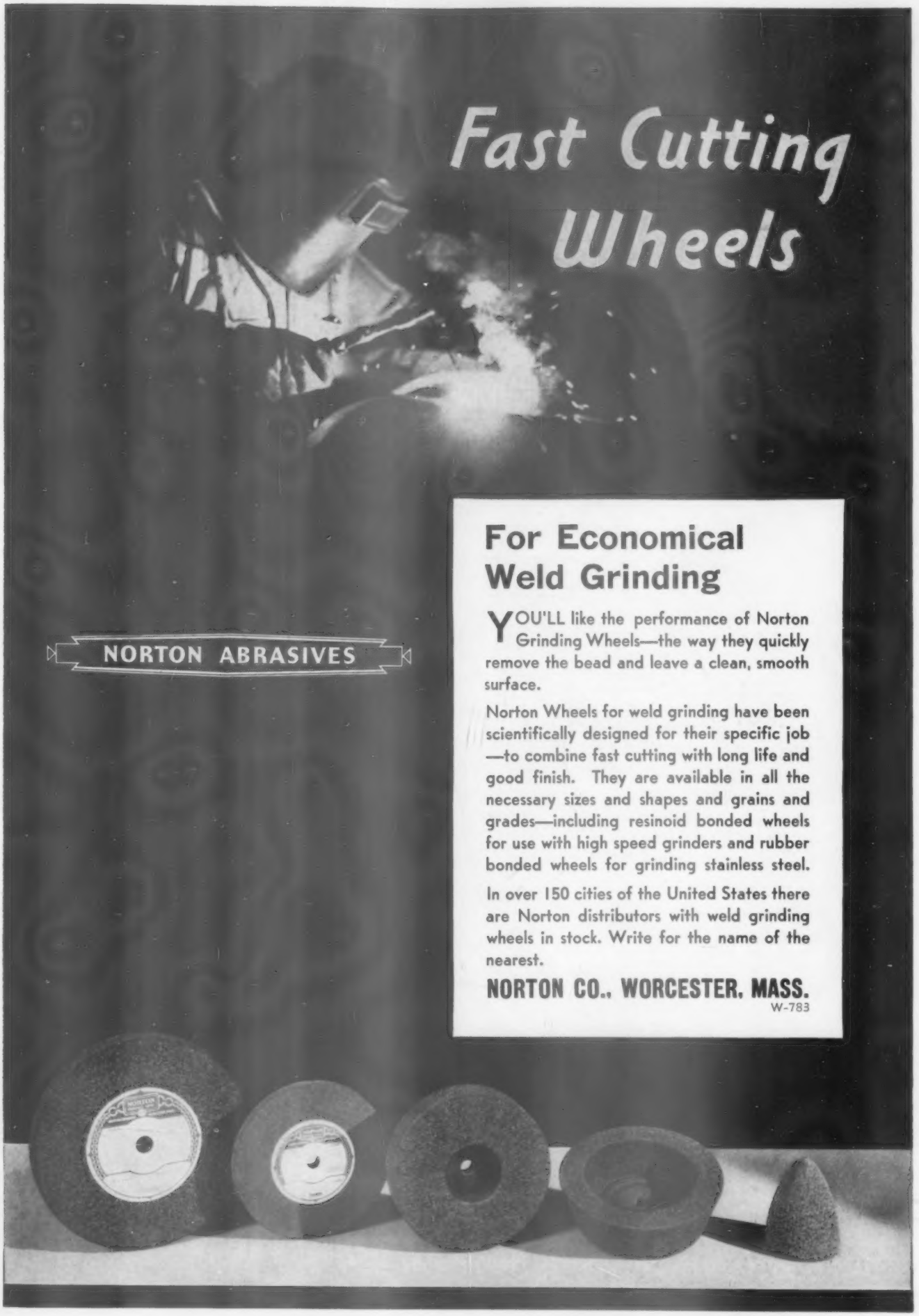
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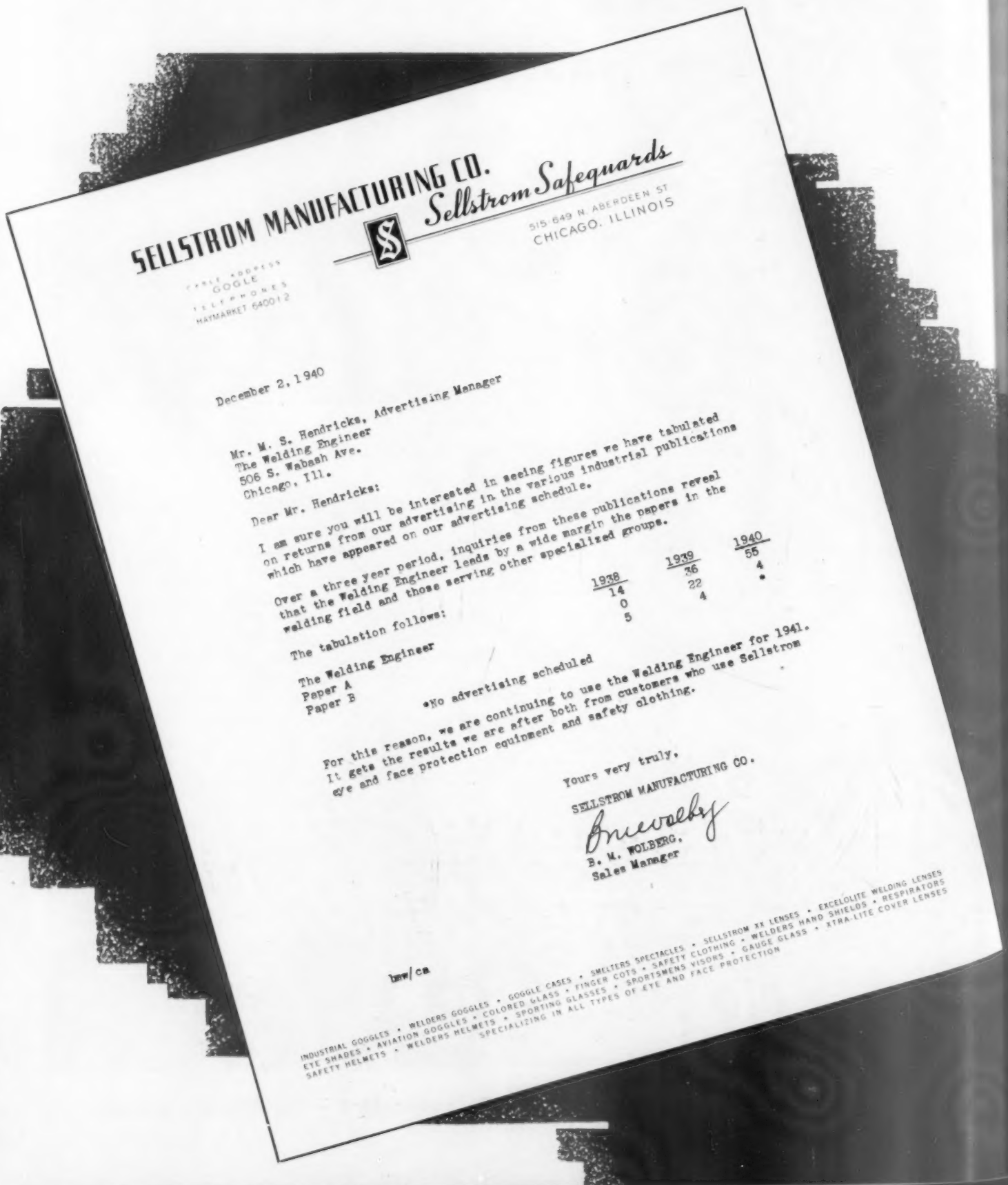

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December 2, 1940

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The Welding Engineer
506 S. Wabash Ave.
Chicago, Ill.

Dear Mr. Hendricks:

I am sure you will be interested in seeing figures we have tabulated on returns from our advertising in the various industrial publications which have appeared on our advertising schedule.

Over a three year period, inquiries from these publications reveal that the Welding Engineer leads by a wide margin the papers in the welding field and those serving other specialized groups.

The tabulation follows:

	1938	1939	1940
The Welding Engineer	14	36	55
Paper A	0	22	4
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*No advertising scheduled

For this reason, we are continuing to use the Welding Engineer for 1941. It gets the results we are after both from customers who use Sellstrom eye and face protection equipment and safety clothing.

Yours very truly,

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B. M. WOLBERG,
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"We are continuing to use Welding Engineer in 1941,"

says B. M. Wolberg

Sales Manager, Sellstrom Mfg. Co.

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A sound product, presented in a well conceived advertising program will get ready acceptance from the buyer-readers of The Welding Engineer.

Editorially, The Welding Engineer is geared to the needs of industry which uses welding in its fabrication. The editor, out of long experience and training, speaks the language of welding men and knows the needs of those men. The Welding Engineer is directed into all those channels where the needs for welding knowledge is greatest. It reaches executives, engineers, designers, foremen and welders—the men who use welding products, pass on their worth and give the orders to BUY.

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GREATER ACCURACY—LOWER COSTS

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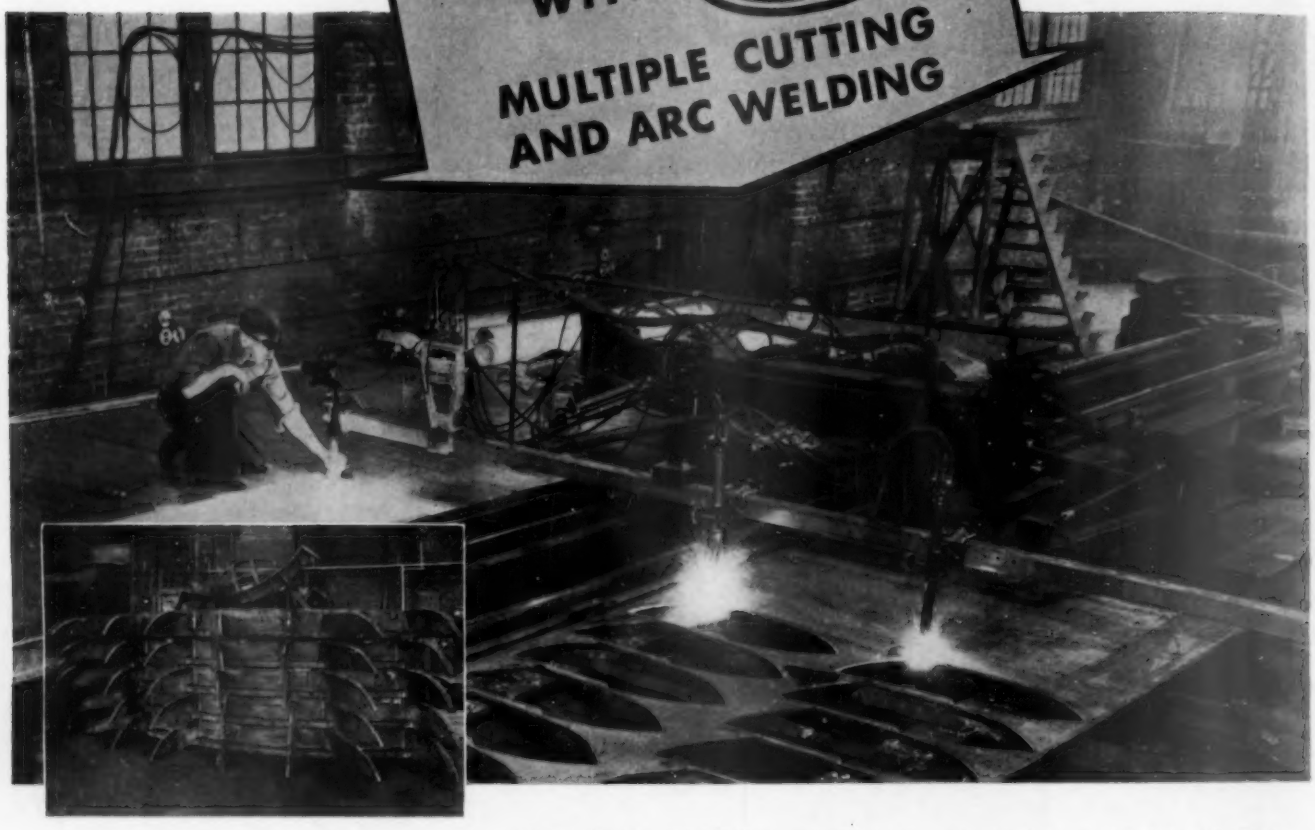
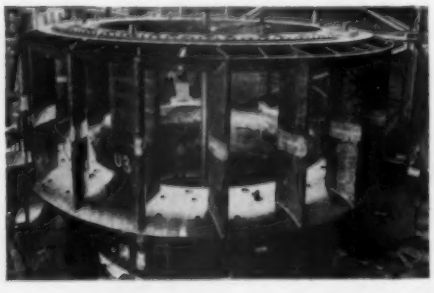


Shop assembly of weld fabricated turbine parts.



Weld fabricated sub-assemblies of ribs and bracing structure.

These three outstanding results — so necessary in maintaining today's production peaks — were attained by the S. Morgan Smith Company in fabricating several important parts of a 74,000 h.p. hydraulic turbine, the speed ring assembly of which is shown here. These particular parts weighed 372,000 pounds. Using an Airco No. 20 Travograph, multiple shape cutting of the steel parts speeded up production considerably. Cutting was so accurate that the close fits obtained decreased assembly time.

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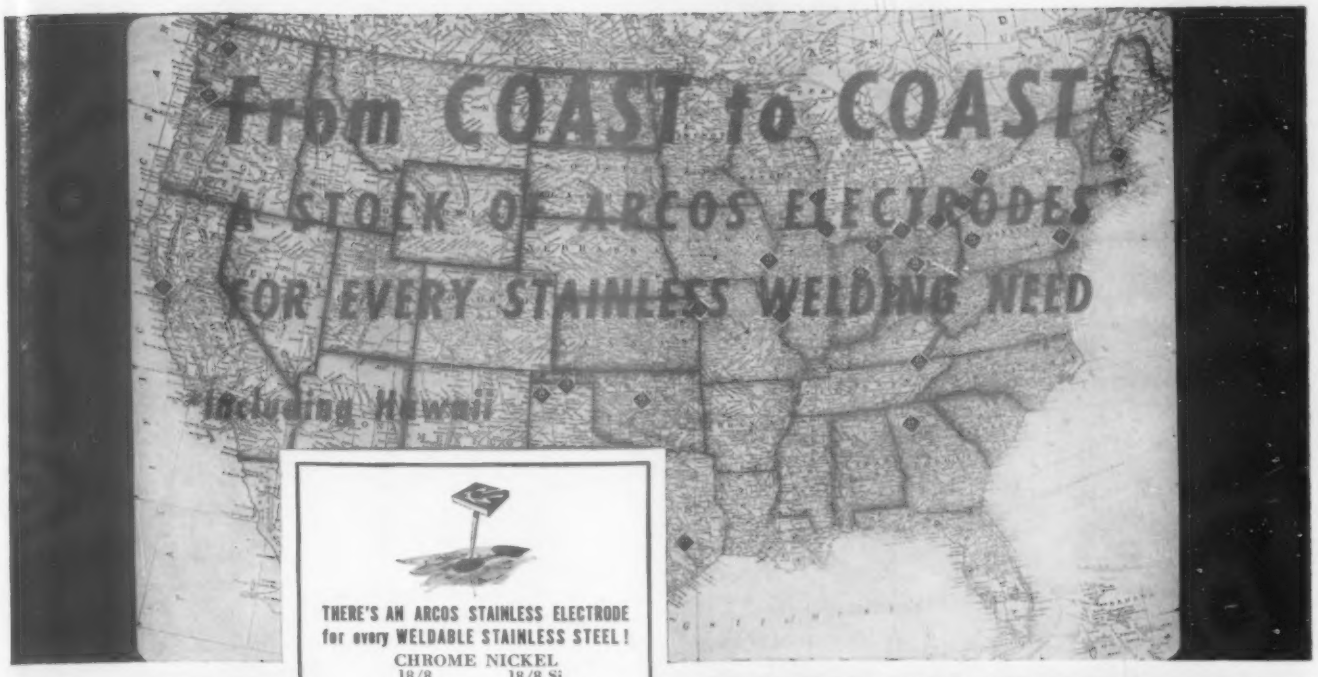

THERE'S AN ARCOS STAINLESS ELECTRODE for every WELDABLE STAINLESS STEEL!

CHROME NICKEL	
18/8	18/8 Si.
8/18	25/12
28/3 Mo.	25/12 Cb.
29/9	25/20
19/9	17/25
19/9 Cb.	15/35
18/8 Mo.	13/60
15/85	

STRAIGHT CHROMIUM	
2% Cr.-Mo.	16% Cr.
4-6% Mo.	18% Cr.
12% Cr.	28% Cr.

Arcos carries 28 analyses in stock; chrome-nickels; straight chromes; chrome-molys; bronzes; nickels; aluminum. Special analyses on order.

A NATIONAL SERVICE FOR WELDERS of STAINLESS

ARCOS distributors are located in all central industrial areas. Warehouse stocks are immediately available in the cities listed below . . . All but the most technical questions can be readily answered by the distributor organizations who are well informed as to the grades and uses of Arcos electrodes.

Atlanta, Ga. . . . . . J. M. Tull Metal & Supply Co.
Buffalo, N. Y. . . . . . Root, Neal & Co.
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Cincinnati, Ohio . . . . . Williams & Co., Inc.
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Columbus, Ohio . . . . . Williams & Co., Inc.
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Milwaukee, Wis. . . . . . Machinery & Welder Corp.
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New York, N. Y. . . . . . H. Boker & Co., Inc.
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Pampa, Texas . . . . . Hart Industrial Supply Co.
Pittsburgh, Pa. . . . . . Williams & Co., Inc.
Portland, Oregon . . . . . Industrial Specialties Co.
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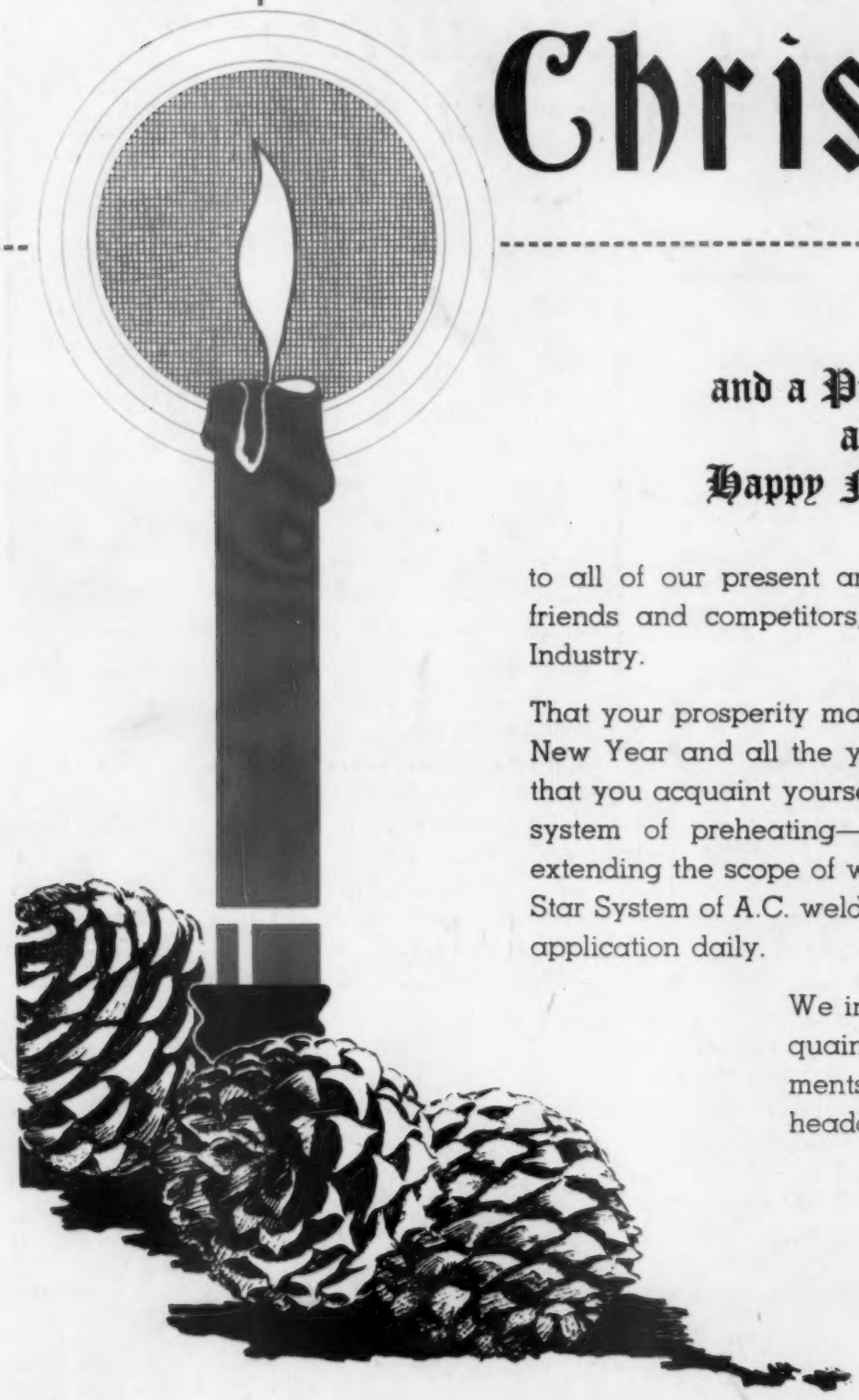
ARCOS TECHNICAL BULLETIN NO. 4

DEPOSITION RATE GRAPH—estimate accurately quantity of electrodes needed, and welding time required. DATA on Cr. and Cr.-Ni. alloy weld metal; types of service for each grade, and recommended heat treatment. COMPLETE LIST of Arcos stainless electrodes and chemical analysis of weld metal obtained. CURRENT RANGE for each size of electrode shown on graph. An indispensable pocket size guide. *Write for your free copy today—or you may obtain Bulletin No. 4 from your distributor.*

ARCOS CORPORATION
Dept. C, 401 N. Broad St., Philadelphia, Pa.

A Merry Christmas



and a Prosperous and Happy New Year

to all of our present and prospective customers, friends and competitors, throughout the Welding Industry.

That your prosperity may continue throughout the New Year and all the years to come, we suggest that you acquaint yourself fully with our induction system of preheating—welding—normalizing for extending the scope of welding. And our Multiple Star System of A.C. welding which is finding wider application daily.

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We announce the "Arc Welding Instruction Book," Eleventh Edition, 300 pages. First published in 1918, this completely revised text brings up to date welding practice on clad and stainless steels, preheating—welding—normalizing, etc.

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